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NUMBER 1

DIVISION OF THE NERVES AND TENDONS OF THE HAND

WITH A DISCUSSION OF THE SURGICAL TREATMENT AND ITS RESULTS¹

SUMNER L. KOCH, M.D., F.A.C.S., AND MICHAEL L. MASON, M.D., F.A.C.S., CHICAGO

IT is inevitable that men who are working along similar lines and who are interested in the same subject should often arrive independently at similar conclusions. In expressing such conclusions one may unwittingly assume that he is stating something that has not been expressed before and fail to realize that other workers in the same field have, perhaps long before stressed the very facts and principles that have come to seem to him of fundamental importance. A few years ago in discussing the immediate treatment of injuries of the hand we emphasized the importance of a careful examination to determine the nature and extent of the injury before any operative treatment was attempted. Doubtless the same idea has been voiced by many men but we only realized a few months ago that Torr W. Harmer (28) in 1922 had stressed it so definitely and described the method of examination so clearly that we seemed almost to be taking the words from his mouth.

Similar statements could doubtless be made concerning many of the details of technique which are suggested in the following pages. Incisions which avoid flexion creases and which permit one to lay an intact flap of skin and subcutaneous tissue over sutured tendons and nerves have been advocated particularly by Bunnell² and by Harmer.

¹"It is important to have the skin incision remote from the tendon graft and tendon suture." Bunnell (20).

²From the Department of Surgery, Northwestern University Medical School. Read in part before the Boston Orthopedic Club, Boston, Massachusetts, April 11, 1932.

The importance of avoiding trauma and of handling tissues with the utmost gentleness is a primary article of faith with good surgeons everywhere. It was one of the principles that Halsted implanted so deeply in the minds of all his students.³

In connection with the surgical treatment of nerve and tendon injuries the importance of such technique has been frequently emphasized by both Bunnell and Harmer by Steindler by Stoeckel by Naffziger by Garlock by Pollock and Davis and by many others. Bunnell in 1921 presented a paper entitled "An Essential in Reconstructive Surgery—Atraumatic Technique" devoted essentially to this one point, and in his later papers

³"All of his publications had a very practical application, many of them precedents for, for example, his introduction of the use of rubber gloves in surgery, his insistence upon the most meticulous care in the gentle handling of tissues, aseptic asepsia and complete hemostasis." Farney.

"He learned how to treat the tissues as he made the wound that was later to heal. He treated them tenderly and watchfully, gently separating them and tying with extremely fine black silk every minute blood vessel—so that in the course of his dissection everything was left clean and dry and above all not bruised or strained. Usually careful was his attention to the bringing together of the tissues when the wound was to be closed—fascia exactly suited to fascia, muscle to muscle, layer to layer, and finally the skin with carefully placed sutures." McCallison.

He demonstrated that a operation lasting three and even four hours, if all the principles of surgery were utilized, did little harm to the patient. His painstaking devotion to hemostasis, to suture to the delicate handling of tissues and to the artistic finish of his handiwork were of the greatest value to surgery. He introduced new hemostatic forceps with small jaws at the crutching points so that a minimum of tissue beyond the vessel was injured; he demonstrated the great decrease in the reaction in the wound when fine silk ligatures were used that included only the injured vessel; and his representation of a wound attempted to bring together the tissues layer by layer as they belonged and without leaving dead spaces. His cases were a forcible demonstration of the fact that if the volume of blood is not diminished and the patient not otherwise thus mutilated, the duration of the anesthetic is of relatively little importance. Cather.

constantly emphasized its importance. How well his results have justified his teaching is attested by Mayer's tribute. His work is famous the world over. There is no one who can do what he can. His results are accomplished by a technique that rivals that of the most proficient musician. His paper on

Reconstructive Surgery of the Hand is the best article we have read on the subject. It could well serve as a textbook for every surgeon who is seriously trying to achieve good results in hand surgery.

The contributions of Leo Mayer and Steindler to the subject of tendon surgery are equally well known to every worker in this field. Mayer's original papers on the anatomy and physiology of tendons and his monograph on tendon transplantation written in collaboration with Professor Biesalski are outstanding contributions to the surgery of tendons.

In addition to the men mentioned are many others,—Auchincloss, Garlock, Mather, Bloch and Bonnet, Iselin—whose names need only be mentioned to recall to the reader their interest in the surgery of tendons and the many helpful suggestions they have made toward its improvement.

We are equally indebted to another group of workers who have concerned themselves particularly with the physiological and pathological changes involved in nerve injuries, with methods of repairing such injuries, and with the clinical symptoms and signs following injury and operative treatment. The experimental studies of Howell and Huber, of Kirk and Lewis, and of Ranson on the processes of nerve degeneration and regeneration, the experimental work of Huber and his colleagues on nerve suture and nerve transplan-

tation and the careful clinical studies of Pollock on a large number of patients who had sustained various types of nerve injury are outstanding contributions in the American literature. Naefziger's paper on end-to-end suture of peripheral nerves is an admirable and comprehensive presentation of the technique of nerve suture. It is one of those contributions to which the student continually returns for helpful guidance. Stookey's well known volume on the surgical and mechanical treatment of peripheral nerves, Lewis' chapter on peripheral nerves in *Lewis' Practice of Surgery*, Foerster's encyclopedic monograph on the anatomy and physiology of the peripheral nerves, and on gunshot wounds of the peripheral nerves, and Pollock and Davis' monograph on peripheral nerve injuries are more recent contributions which cover in a thorough and exhaustive fashion the entire subject of peripheral nerve injury and repair. Babcock and Bower, Bunnell, Delagénère, Eisberg and Sonnenschein, Eisberg, Frazier, Joyce, Kennedy, Platt, Souttar and Twining and Stopford are only a few of many others who have made helpful contributions to the subject of peripheral nerve surgery.

Finally we personally are very greatly indebted to Allen B. Kanavel for the helpful advice, the imagination, the enthusiasm and the constant encouragement which he has given so generously to those who have had the good fortune to be associated with him. Many of the cases which are reported in the following pages have been his cases. The technique which we have described is patterned after his teaching, and if we have secured good results it is because we have tried faithfully to carry out the surgical principles which he has striven so hard to instill into us.

A primary consideration in the immediate treatment of an injury with tendon and nerve involvement, and one which is often neglected is a careful examination of the patient to determine the degree and extent of injury.⁴ Its importance may be illustrated by brief mention of a specific case. A man was seen two weeks after he had sustained a transverse cut

over the volar surface of the right wrist. He had been operated upon less than two hours after the injury. His first words were, "I have had no feeling in the palm since the injury." In answer to our questions the surgeon wrote "I know there was no nerve injury" for immediately after completion of the operation the patient was able to flex all his fingers.

Aside from the obvious fact that it is impossible to divide the flexor tendons by a

The necessity for careful examination before operation on the injured hand was mentioned above, but we believe the point is of such importance as to justify calling attention to it again.

transverse cut across the volar surface of the forearm just above the wrist without dividing the median nerve and that it is difficult to divide the tendons without dividing the ulnar nerve (Fig. 1) is the often forgotten fact that even if both median and ulnar nerves are divided at the wrist a patient can flex his fingers if the flexor tendons are intact since the long flexor muscles receive their innervation from the median and ulnar nerves high up in the forearm.¹

Textbooks have made the picture of median and ulnar nerve injury unnecessarily difficult to visualize and remember and these particular injuries are stressed because they are so common and so important. There are two pathognomonic signs of median nerve injury below the middle of the forearm—loss of sensation in the area of median nerve distribution (Fig. 2) and the inability to rotate the thumb to face the fingers.² Similarly there are two diagnostic signs of ulnar nerve injury below the middle of the forearm—loss of sensation in the area of ulnar nerve distribution (Figs. 2, 3) and loss of the ability to abduct the completely extended fingers from and adduct them to the midline of the hand. Such movements do not of course represent the entire motor function of the median and ulnar nerves but they are unequivocal and diagnostic.

The function of the radial nerve (Fig. 3), of the digital nerves, of the long flexor tendons of thumb and fingers and of the extensors of the thumb and fingers are too well known to require comment and yet the failure to examine the hand and determine the extent of loss of function of nerves and tendons before carrying out any operative procedure often leads to unfortunate complications. "Forewarned is forearmed," and the surgeon who knows before operation that a certain nerve or

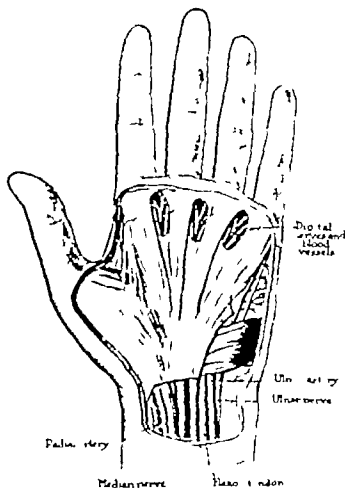


Fig. 1. Dissection of the volar surface of the wrist showing the superficial position of the median and ulnar nerves, and the similarity in size between the median nerve and the superficial flexor tendons (after Sobotta).

tendon has been divided will not fail to find the injured structure and reunite it. How easy it would be to overlook certain nerve and tendon injuries if the pre-operative findings had not made one certain of their presence, the experienced surgeon knows full well.³

¹ So able a surgeon as John B. Murphy in discussing the loss of ability to flex the fingers in a patient who had sustained a deep glass cut across the volar surface of the wrist stated: "there may be something wrong with the median nerve which supplies these muscles, and, a little later, if the tendons were cut and then sutured, why is their function now suspended? It must be that the tendons either were cut and not sutured at all, or that they have become immobilized by adhesion to the structures in the neighborhood. A third possibility is that there is some thing wrong with the nerve supply. I feel possible that the median nerve was divided and not reunited."

Pollock (58) has shown that in cases of median nerve injury the tip of the thumb can be opposed to the little finger by contraction of the flexor pollicis brevis and adductor pollicis. This movement, however, is not true rotation of the thumb, for the thumb is moved in a plane parallel to the palm.

³ The emphasis that has been placed on the pre-operative examination of the injured hand is made with particular reference to the patient who is seen immediately after injury. It is unnecessary to add that the patient who comes for secondary operation should have as careful a examination and as accurate a pre-operative diagnosis as possible. With this, however, to emphasize the importance of not delaying operation in late cases in which the exact diagnosis is in doubt until the most opportune time for operation, and particularly for nerve suture, has passed. It has invariably been our experience that in cases in which because of evidence of returning sensation there was doubt as to whether the nerve was completely divided, as to whether it had been properly united at the original operation, or as to whether spontaneous recovery was taking place the extent of nerve injury found at operation was considerably greater than anticipated. Frequently in such doubtful cases we have found nerve ends so widely separated that there was no possibility of union taking place without surgical intervention. The careful clinical studies of Pollock, particularly with reference to the development of over-lap from adjacent nerves in an area whose normal sensory innervation has been destroyed, have been of very great assistance in helping us to understand these apparent anomalies, and to realize the importance of not placing too great reliance upon the evidence of returning sensation in an area whose nerve supply has once been cut off.

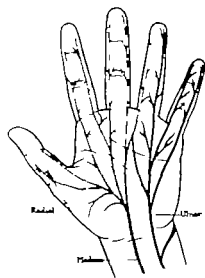


Fig. 2 The sensory nerve supply of the palm (after Spalteholz)

A second and important consideration is that, to the patient who has sustained an injury with division of tendons and nerves, the greatest immediate danger lies not in the fact that function of the tendons and nerves has been lost, but that he has sustained an open wound through which virulent bacteria may gain access to the deeper tissues and in the manipulation and dissection incident to repair of the injured structures these virulent bacteria may be disseminated widely and with disastrous results.⁸ Such infection may jeopardize the patient's life. It cannot help but jeopardize the success of the operation for no single factor is so important to success in the repair of tendon and nerve injuries as healing by primary union.

Although infection does not develop in every case in which immediate suture is performed (Figs. 4, 27, 28) it happens far too often. During the past year we have seen six patients, two of them physicians, in whom the immediate suture of divided tendons was followed by spreading infection, extensive sloughing, long continued suppuration and eventually healing with marked loss of func-

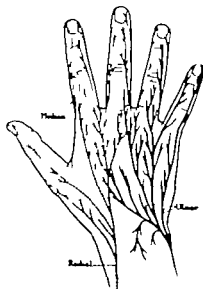


Fig. 3 The sensory nerve supply of the dorsum of the hand (after Spalteholz)

tion. Such complications can be avoided by limiting very definitely the indications for immediate operation and by permitting cases in which these indications are not present to go on to complete healing before attempting surgical repair.

Under what conditions is one justified in carrying out immediate operation? In other words, under what conditions has one a right to expect wound healing without infection? A number of factors come into consideration: the conditions under which the injury has been sustained, the character and extent of the external wound, the exact location of the injury, the first aid treatment rendered, the time that has elapsed since the injury and finally the facilities available for its repair. If a tendon or nerve injury is the result of a clean cutting wound—from a glass, or broken bottle or a porcelain water faucet, sustained indoors, and if the patient's hands are clean there is a reasonable chance that the wound is not infected (Fig. 4). This possibility becomes less when the patient's hands are soiled or covered with dirt and grease when the injury is sustained out of doors—from flying glass, broken windshields, etc. and when the external wound is a jagged lacerated wound of considerable extent (Fig. 5). The exact location of the injury is of importance. Tendons

⁸Garlock has emphasized the importance of delaying operation on injured tendons "when the wound is ragged and dirty, abnormally grossly contaminated and the surrounding skin is covered with grime and dried blood." We agree entirely with Garlock's statement, but would insist much more strictly and definitely the indications for immediate operation.

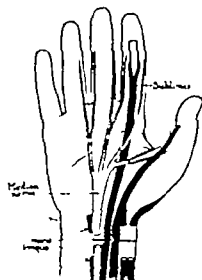


Fig. 4a.

Fig. 4. Division of median nerve, of flexor carpi radialis, abductor pollicis longus, palmaris longus, and partial division of flexor pollicis longus and flexor sublimis of index finger from a fall on a broken water bottle. Soap and water cleaning; primary nerve and tendon suture under ethylene anesthesia 1½ hours after injury—primary union. a. Findings at operation. Solid black lines indicate injured tendons. b. Result 4½ months after operation. c, d. Sen-

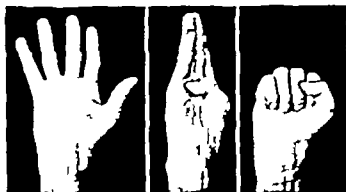


Fig. 4b.

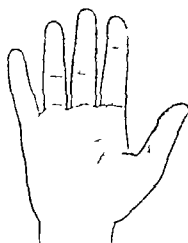


Fig. 4c.



Fig. 4d.

seny findings 4½ months after operation. Dotted area indicates loss of response to light touch oblique lines loss of response to pin prick.

which are surrounded by definite sheaths are more vulnerable than those which are surrounded only by areolar tissue. Infection introduced into an open tendon sheath spreads readily from one end of the sheath to the other and very quickly involves its entire extent. If no sheath is present localization of the infection is favored and widespread diffusion of an infectious process is less likely to take place. The first aid treatment is of importance. If considerable bleeding occurs bystanders become alarmed and often contaminate the wound in their anxiety to control the hemorrhage. The time element is important. If the injured hand is seen immediately, there is little opportunity for bacterial growth to take place, but if more than four hours have elapsed we believe it is unwise to attempt primary operative repair. Finally it seems unnecessary to say that the suture of divided tendons and nerves is a major operation and one that should not be performed except in a well equipped operating room yet one fre-

quently sees cases in which such repair has been attempted in a doctor's office or a hospital emergency room with results that are far from ideal and difficult to counteract.

To state it in positive terms instead of negative terms it is our belief that an immediate repair of divided tendons and nerves is justifiable if the wound is a clean cutting wound made by sharp instruments if the wounded hand is clean if the cut is sustained indoors if the first aid dressing has been sterile if the patient is seen within a few hours of the time of injury and if a well equipped operating room is available for surgical treatment.

If the median or ulnar nerve alone has been divided, without injury of tendons, one is justified in performing an immediate suture in some cases in which with extensive tendon injury immediate operation would not be justified because divided nerves do not retract as divided tendons do and an extensive dissection to expose them is rarely necessary, and because the results of immediate nerve suture

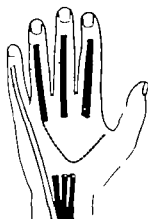


Fig. 5a.

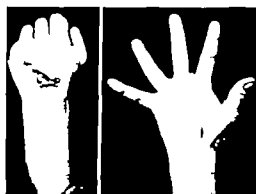


Fig. 5b.

Fig. 5. Division of extensor tendons of index, middle and ring fingers by the edge of a broken mirror. Tendon suture under ether anesthesia 4 hours later followed by wound infection and suppuration, healing complete in 7½ weeks. Excellent functional result in spite of postoperative infection. a. Findings at operation. Solid black lines indicate divided tendons. b. Result 1 year after operation.

particularly as regards the return of motor function are so much better than the results of delayed suture that one is justified in taking a somewhat greater chance in order to secure an immediate end-to-end apposition.

If the conditions described above are not present it is wiser to close the superficial wound loosely with a few interrupted sutures and permit healing to occur before attempting repair of the injured tendons and nerves (Figs. 6-7). One should be particularly conservative about attempting immediate suture of tendons surrounded by a sheath. One occasionally sees cases in which the suture of tendons on the back of the hand has been followed by a slight localized infection without serious impairment of the operative result (Fig. 5) but we can recall but one case in which a low grade infection developed after suture of flexor tendons without impairment of the final result. In the majority of such cases which have come under our observation there has been extensive spreading of infection with eventual necrosis and sloughing of tendons, and in some cases sloughing of superficial tissues and ankylosis of joints as well—conditions which make it necessary to postpone any attempt at operative repair for long periods of time and often make operative restoration almost impossible to accomplish.*

*Our emphasis upon the importance of delaying nerve and tendon re-

It is not necessary to present examples of the poor results of primary tendon and nerve suture. They are sufficiently common to have inspired considerable distrust in the medical profession concerning the wisdom of any operation upon tendons and nerves. On the other hand, it is hardly necessary to emphasize the fact that excellent results can be obtained in cases in which operation has been delayed until the original wound is soundly healed and free from every evidence of infection.¹⁰ The duration of this delay depends upon the time required for wound healing, the character and amount of wound secretion and the bacteriological findings. Wounds which heal by primary union can be safely reopened three weeks after the injury. If any wound discharge has been present it is wise to wait for three months after the wound is healed before carrying out secondary repair (Fig. 8). If the infection has been due to a hemolytic streptococcus we believe that one must wait until the wound has been completely healed and free from discharge for twelve months

before one is certain that the wound is not infected in the result of our own early experience with a few cases in which we performed primary nerve and tendon suture and our observation of the results in considerably larger number of cases in which immediate operation had been carried out elsewhere.

Our own results following immediate nerve and tendon suture are discussed in more detail under "Manual of Cases of Divided Nerve and Tendons." (pp. 31-56.)

to operate in the face of infection is to court disaster. Lyle. Although the writer was referring to the treatment of peripheral nerve injuries resulting from gunshot wounds the principle holds true no matter what the cause of the wound.



Fig 6a.

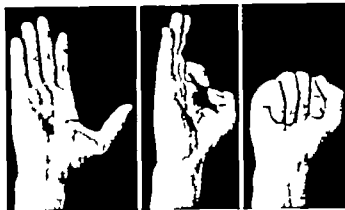


Fig 6c.

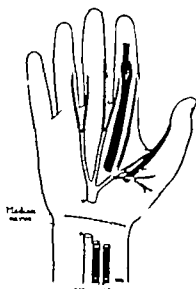


Fig 6b.

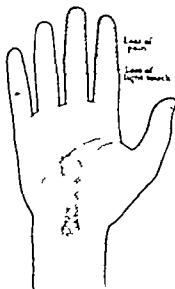


Fig 6d.



Fig 6e.

Fig. 6. Division of median nerve of flexor pollicis longus and both flexors of index finger. Immediate skin suture elsewhere. Primary union. Secondary nerve and tendon suture 26 days after injury. a. Before operation. b. Findings at operation. Solid black lines indicated divided tendons.

c. Result and d, e sensory findings 17 1/2 months after operation. Dotted area indicates loss of response to light touch. oblique lines loss of response to pin prick. In spite of the objective loss of response to light touch the patient states that sensation is practically normal.

before he can carry out extensive secondary operations without danger of lighting up a latent infection

OPERATIVE TECHNIQUE

In the surgical treatment of tendon and nerve injuries several technical details are of great importance. First of these is care to ensure asepsis. In our judgment nothing in the way of surgical skill, accurate apposition of tendons and nerves, postoperative care, or postoperative physical therapy can compensate for failure to secure healing by primary union.¹¹ To render such healing as nearly cer-

tain as possible the hand and forearm are carefully prepared by thorough and prolonged cleansing with soap and water the afternoon before operation. A sterile dressing is then applied and left in place until the patient reaches the operating room. Just before operation the hand and forearm are painted with a solution of five per cent picric acid in fifty per cent alcohol.¹² An area on the ab-

very exceptional occurrence. Therefore the greatest care to prevent the entrance of organisms into the wound is a rule the importance of which cannot be overestimated. — Kennedy

11. The occasional case in which we have had the opportunity of operating upon patients with divided nerves and tendons within a few hours of the time of injury. It has for some years been our custom to prepare the field of operation in the operating room and, if general anesthetic is given, after the patient is anesthetized.

12. Sterile dressings are laid over the wound itself and a wide area around it shaved and cleaned with soap and water. Next the wound itself is carefully cleansed with soap and water and with the help of small gauze

11. Aseptic technique of a high standard is essential if good results are to be expected. It is no proof to the contrary if a case of nerve suture has become septic and yet a good result has followed. It will certainly be



Fig. 7a

Fig. 7c

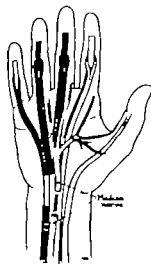


Fig. 7b

Fig. 7 Division of median nerve, of both flexor tendons of middle and ring fingers, and of superficial flexor tendon of little finger. Immediate closure of skin wound; primary union. Secondary nerve and tendon suture 2 weeks later; primary union. Secondary formation of a small scar which remained unhealed until a single suture sloughed out 6 weeks after operation. a. Before operation. b. Findings at operation. Solid black lines indicate divided tendons. c. Result 2 years after operation.

dominal wall from which subcutaneous fat can be obtained is prepared in the same way and if there is a likelihood that tendon grafts will be needed a foot is also prepared. In the operating room sterile linen is applied in such a way that hand, abdomen and foot are accessible without shifting the sterile linen once it is in place.

Everyone who enters the operating room is masked; the nose is covered as well as the face for we are convinced by our own clinical experience, and by Meleney's bacteriological studies that serious wound infection can result from failure to mask the nose as well as the mouth of everyone in the operating room.

sponges held in sterile forceps. The final step in cleansing is irrigation of the wound with considerable quantity of warm sterile water.

We believe considerable harm is done to delicate and fragile tissue cells by irrigating such a wound with powerful chemical solutions, such as tincture of iodine, 5 per cent alcohol, etc., and that this harm outweighs any possible good that can be accomplished.

Although approximately one third of our cases have been operated upon under local anesthesia we prefer to use nitrous oxide, ethylene or ether unless there is a contra-indication for so doing. Scar tissue particularly is difficult to infiltrate and render anesthetic by local infiltration. The injection itself adds a certain degree of traumatism. If tissues, particularly covering tissues are already devitalized we cannot with safety use an anesthetic solution containing adrenalin and solutions without adrenalin do not render the part anesthetic for a long enough time to permit one to carry out a complicated operation. Finally the pressure of the blood pressure band may become unduly painful for the unanesthetized patient after 30 or 40 minutes and make it necessary to release the constriction just at the moment when a bloodless field is essential.

Brachial plexus anesthesia has certain theoretical advantages. Practically we have found it difficult to secure constant and satisfactory anesthesia with this method and in attempting it we have always been concerned with the possibility of doing harm to important nerves or blood vessels by such a blind procedure.

Just before the operative incision is made the extremity is elevated for a few moments and the blood pressure cuff applied beforehand, inflated to 220 or 230 millimeters. A bloodless field is indispensable for careful and accurate dissection and suture.

Finally it should be unnecessary to repeat that gentleness in the handling of tissue as has been so forcefully emphasized by Bunnell,



Fig. 8a.



Fig. 8b

don clamp to facilitate tendon suture we have finally come to depend upon very simple instruments: fine tissue forceps with teeth so called Adson forceps; very fine straight arterial needles for tendon and nerve suture. No D Corticelli white silk for the retention suture in the tendon and No A Corticelli black silk for the coaptation suture in the tendon and for nerve suture. Fine round needles with fine silk for suturing the deep fascia and subcutaneous tissue, and fine cutting needles with fine der-

Fig. 8. Division of nerves and tendons of volar surface of forearm just above wrist from fall on a piece of glass. Nerve and tendon suture elsewhere 2 hours later: primary union, persistent loss of sensation in palm and inability to extend fingers. At operation 3 months later median nerve and flexor tendons found fused into a single mass containing many strands of coarse silk at the site of the divided ulnar nerve was a pecan sized abscess filled with gelatinous,

purulent fluid. Contents of the abscess carefully wiped out; neurolysis of median nerve; tendolyses of flexor tendons, and end-to-end suture of ulnar nerve. Operative wound reddened and tender for some days, but healed by primary union. Cultures of abscess showed slowly growing colonies of staphylococcus albus. a. Before operation. b. Result 7 months after operation: the fingers can be flexed completely and extended almost to a straight line.

by Harmer by Naffziger by Pollock and Davis and many others is of paramount importance in the treatment of nerve and tendon injuries. This gentleness must be directed not only to the handling of nerves and tendons but to the superficial tissues as well. Necrosis of skin edges along the line of suture may result from forceful retraction and rough handling with tissue forceps and Allis forceps. Skin flaps often have diminished vitality because of the original injury and the subsequent scar tissue formation. Care and gentleness throughout the operation are important factors in helping to secure the primary wound healing which is so essential a factor in bringing about a successful result.

Although we have used special instruments for holding tendons and have devised a ten-

mal suture or silk for the closure of the skin.

A sterile bipolar electrode to stimulate an injured nerve with the faradic current and enable one to determine the presence or absence of conducting fibers has been recommended by some surgeons as an essential feature of the operating room equipment. Although we have constantly kept such an apparatus available we have not found it of practical value. In the great majority of cases in which we were in doubt as to whether nerve division had been complete or whether spontaneous recovery was taking place we have found at operation unmistakable evidence of extensive injury, usually greater than we had anticipated. In a number of cases of median nerve injury, for example, in which the return of sensation in the area of median nerve distr-



Fig. 9

Fig. 9. Preferred incision for exposing divided nerves and tendons over the volar surface of the wrist

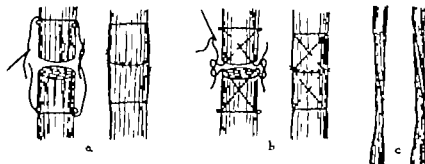


Fig. 10. Method of approximating the ends of divided tendons. a. The preferred method. b. An alternative method. c. Method of approximating the fragmented ends of scarred tendons when end-to-end union of freshened tendon ends is impossible because of extensive destruction of tissue.

bution suggested that recovery was taking place we have found the nerve ends widely separated and in other cases the proximal segment of the nerve united to a tendon and the distal segment lying free in the scar tissue floor of the wound. In no case in which the pre-operative examination left us in doubt as to whether recovery was taking place and in which at operation nerve ends were found united by a fairly normal appearing spindle of scar tissue were we able to secure a response from electrical stimulation of the nerve in question and therefore determine that resection of the neuroma and suture would not be necessary. In the majority of such doubtful cases resection of the scar tissue showed smooth connective tissue uniting the nerve ends and forming a complete block to the downgrowth of axons. Occasionally the excised section showed on its cut surface a few apparently intact nerve fibers, but in these cases also stimulation of the nerve above the site of injury had failed to produce contraction of the muscles supplied by the nerve in question.

INJURIES OF THE VOLAR SURFACE OF THE FOREARM AND WRIST¹³ (Figures 4, 6 7 8 13 14, 16 17 18 41 42 43)

The incision is planned if possible so that a flap of skin and subcutaneous tissue overlies the line of tendon and nerve suture (Fig. 9).

In the following discussion of the technique of operation in different locations and the operative technique of choice we have included the cases

It is very difficult to secure accurate and complete apposition of skin edges at and above the wrist when it is necessary to flex the wrist to permit nerves and tendons to come together without tension but the difficulty is lessened if the incision crosses the flexion fold at the wrist near its radial or ulnar border.

After the incision is made the median nerve is dissected free, first above and then below the site of injury. It is always sought in sound tissue, and traced from above and below to the site of injury.¹⁴ Just above the wrist except for the palmaris longus, it is the most superficial structure underneath the deep fascia (Fig. 1). Higher in the forearm it lies at a deeper level between the superficial and the deep flexor tendons. It can be distinguished by its slightly dull grayish-white color in contrast to the glistening yellowish white of the tendons, by its faint longitudinal striations, and by the tiny blood vessel that often lies upon its surface. It cannot be differentiated from the tendons among which it lies by its size. This probably accounts for the fact that in secondary operations one often finds the proximal segment of the divided median nerve sutured to the distal segment of one of the divided tendons. In locating the distal segment of the divided median nerve one should remember that it lies directly underneath the transverse carpal ligament. The ligament is thick and tough; it often closely resembles scar

in which operation is carried out after sound healing is complete, in other words, the secondary operation. If one has the opportunity of operating upon a case immediately after injury obviously he will adapt the operative measures to the open wound which is already present.

A long incision. Identification of the distal and proximal portions of the nerve in their normal relations above and below the scar is the first step. McAllister

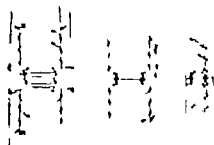


Fig. 11 Harmer's method of approximating the ends of divided tendons (Boston M. & S. J. 191 clxxvii, 805-810.)

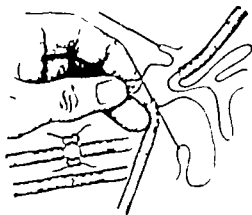


Fig. 12 Bunnell's method of approximating the ends of divided tendons. (J. Bone & Joint Surg. 1925 x, 10.)

tissue Time can be saved by immediately dividing it in a longitudinal direction at the level of the wrist joint. The nerve can then be easily identified as it lies upon the flexor tendons just under the ligament.

After the median nerve is found the ulnar nerve is sought as it lies under cover of the flexor carpi ulnaris just medial to the ulnar artery and vein. In the forearm the accompanying blood vessels help to make easy its identification. The distal segment is more difficult to find particularly if the point of division is close to the wrist. One should remember that as they pass from under cover of the flexor carpi ulnaris the nerve and its accompanying vessels lie just lateral to the pisiform bone, covered by a fascial expansion of the flexor carpi ulnaris (the volar carpal ligament) and that they pass into the hand superficial to the transverse carpal ligament.

in contrast to the median nerve which passes underneath the ligament. Not infrequently one finds the ulnar nerve divided just beyond the site of its division into deep and superficial branches. Both deep and superficial branches must be found and united to the proximal nerve trunk if one is to secure a satisfactory result.

With the nerves freed, covered with gauze or cotton saturated with salt solution and held out of danger the tendons are next identified. Divided tendons always retract and one must lengthen the incision if necessary in order to reach them. When the ends are exposed they can be grasped gently with fine tissue forceps and freed from the surrounding tissues by sharp dissection as far distally as one can see and reach with the knife. The superficial group is separated from the over-



Fig. 13. Partial division of ulnar nerve, complete division of median nerve and all of flexor tendons from fall on a glass bottle. Immediate closure of wound elsewhere primary union. Secondary operation 3 weeks after injury, suture en masse of proximal segments of deep flexors of

four fingers to distal segments; suture of superficial flexor tendons in same way; end-to-end suture of flexor pollicis longus, of median nerve and repair of ulnar nerve. Primary union. Result 3 1/2 months after operation. Patient is developing ability to flex fingers individually.



Fig. 14a.



Fig. 14b.

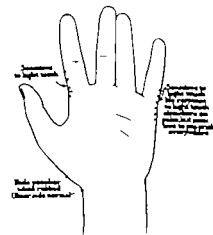


Fig. 4c.

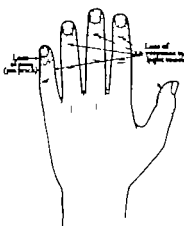


Fig. 14d.

moistened with salt solution¹³ and the retracted tendons drawn proximalward into the wound. In favorable cases the adhesions which have formed in the digital sheaths give way and one can draw the fingers into complete flexion. In other cases the adhesions between the tendons and their sheaths have become so firm that no amount of tension can produce flexion at the interphalangeal joints. If one cannot produce flexion by direct tension upon the tendons one cannot expect the flexor muscles, which have been inactive for some time to produce such flexion after suture has been performed no matter how perfect the healing at the line of suture may be. In such

Fig. 14. Printing press injury just below middle of left forearm with division of median and ulnar nerves and all flexor tendons except flexor pollicis longus. Immediate nerve and tendon suture elsewhere with persistent drainage for 3 months, no functional improvement. Secondary nerve and tendon suture 5½ months after injury primary union. a. Condition before operation. b. Result year 8 months after operation although proximal segments of deep tendons were sutured en masse to distal segments, and superficial tendons united in same way patient has individual action of the index and middle fingers, but ring and little fingers are flexed and extended as one. c, d. Sensory findings year 8 months after operation.

lying fascia and from the deep group and the deep group from the sides and floor of the carpal tunnel. When the surrounding adhesions have been divided not torn as completely as possible the ends of the tendons are grasped between the finger tips covered with gauze

cases in order to secure the desired result we have found it necessary to make an antero-lateral incision in each finger and free the ten-

¹³ Whether we are dealing with tendons or nerves we must handle them as little as possible. I prefer to hold the structure with a piece of moist gauze in my fingers rather than to subject them to the traction compression of smooth forceps, the bite of toothed forceps, or the tearing of tiny hooks. (Harris) (14)

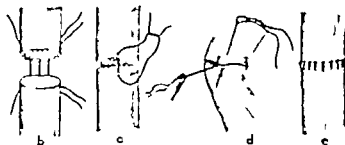


Fig. 15a, c, d, e

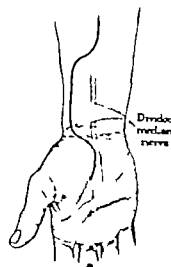


Fig. 15a

Fig. 15 Technique of nerve suture. a, Incision of choice for exposing divided median nerve just above wrist. If necessary incision may be continued proximal ward and distalward in vertical direction. b, First suture is inserted at exact midpoint of dorsal surface of nerve. A second and third supporting suture is inserted close to it before first is tied, to prevent first suture tearing through delicate epineurium as nerve ends are drawn together. c, After three sutures are tied a fourth is inserted at exact mid point of volar surface of nerve. d, Trac-

tion on suture helps to rotate nerve and facilitate introduction of next suture. e, Suture completed. f, Protection of line of suture with thin fat transplant

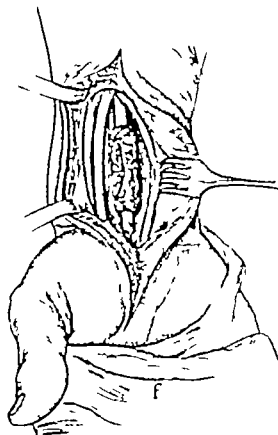


Fig. 15f

separating the muscle bellies of the flexor sublimis from the underlying flexor profundus digitorum the median nerve can be freed almost to the elbow with little traumatism and without destruction of blood vessels. Flexion at the elbow gives still more relaxation. If both median and ulnar nerves are involved, and the loss of tissue is so great that the nerves must be freed to the elbow and the elbow flexed to relax the median nerve it is necessary to isolate the ulnar nerve at and above the elbow, divide the fascial origin of the flexor group of muscles from the medial condyle and displace the ulnar nerve from the olecranon groove to the front of the elbow. As Naffziger has emphasized one should be careful to preserve intact the branches of the nerve to the long flexors of the wrist and fingers. With the ulnar nerve displaced in front of the medial condyle flexion at the elbow relaxes the nerve instead of making it more taut.

trauma and do not secure the greatest lengthening. The attachments of the nerve sheath to surrounding fascia will not be freed by pulling. It is often found that free mobility is prevented by small nerve branches to muscles. Careful exposure of these and gentle dissection of them for some distance up the nerve trunk will be necessary before the desired freedom of movement is obtained." Naffziger

dons from the surrounding tissues by sharp dissection. When this is done the firmest adhesions are usually found at the point of bifurcation of the sublimis, where the tendon of the profundus passes between the two slips of the dividing sublimis and at the proximal end of the digital sheath opposite the metacarpophalangeal joint. We have not been successful in attempting to free the flexor tendons from adhesions to the digital sheaths by 'coring them out' with a modified cork borer.

If nerve destruction has taken place as a result of fibrosis or infection nerves must be freed for a considerable distance proximal ward so as to permit the ends to be brought together without tension. Some relaxation can be obtained by volar flexion of the wrist but if this does not suffice the proximal segments of the nerves must be freed until complete relaxation is obtained.¹⁴ By carefully

¹⁴ Free mobilization of the nerve requires, above all, long incisions. Small incisions and forcible stretching of the nerve produce unnecessary



Fig. 6a.



Fig. 6c.

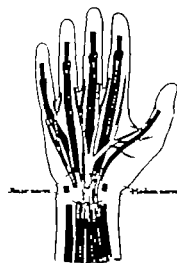


Fig. 6b.

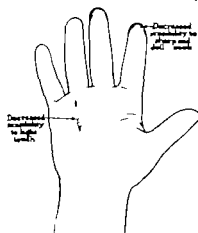


Fig. 6d.

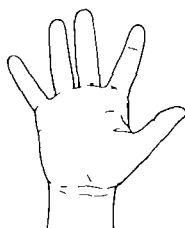


Fig. 6e.

Fig. 6. Division of all flexor tendons, median, and ulnar nerves just above right wrist, immediate surgical repair elsewhere leaving by primary union, but without restoration of function. Secondary nerve and tendon suture 2 months after injury. Healing not complete until 3 small sutures were extruded 3 weeks after operation. a. Before

operation. b. Operative findings. Solid black lines indicate divided tendons. c. Result 3 years after operation. d. Sensory return almost complete 3 years after operation.

Tracing of hand showing degree of abduction of fingers possible 3 years after operation. The most definite evidence of return of motor function of the sutured ulnar nerve

After the dissection is completed and the nerves and tendons are ready for suture the air is released from the blood pressure cuff and any actively bleeding vessels are ligated. The arm is then elevated for a few moments, the cuff reinflated and the constriction maintained until the operation is completed and the bandage applied over the dressings. We have given up attempting to perform tendon and nerve suture in a bleeding field. The oozing from many tiny blood vessels is so great that the field of operation soon becomes discolored and the structures involved diffi-

cult to recognize. The amount of blood so lost is not inconsiderable and the trauma to tendons and nerves from repeated sponging is surely not helpful.¹⁷

Russell has said, "A tourniquet or blood pressure band should always be used to avoid the trauma of sponging" (3) and, "If we operate in a field rendered bloodless by the use of blood pressure band as tourniquet, we may avoid the unnecessary trauma of sponging, and can be clearly seeing the tissues direct with accuracy and minimum of trauma" (4). Taylor has said, "It is hardly necessary to mention that this work should be done in a bloodless field to secure clear recognition of the parts and to avoid the necessity of sponging, which if required, should be done with moist absorbent cotton and not wool" (16) (18).

Some surgeons on the other hand have advised against the use of constrictor on the ground that "protracted constriction may not only affect the nerves, but the interference with circulation may so disturb the nutrition of the parts that repair processes may be retarded and resistance to infection reduced. Furthermore, prolonged use of the tourniquet may be followed by postoperative paresthesia" (14).

Tendons are sutured first and if possible are sutured end-to-end. The type of suture we prefer to use is shown in Figure 10a. This type of suture has been advocated by Friedreich and by Max Lang of Munich. It is not essentially different from the technique advocated by Harmer (Fig. 11) and by Bunnell (Fig. 12). It fulfills the essentials which Mason and Shearon in their experimental studies on tendon suture have found to be of primary importance viz. firm and accurate apposition of tendon ends without interposition of knots between the apposed ends and



Fig. 10a



Fig. 11b

Fig. 17. Division of median and ulnar nerves and of all flexor tendons as result of glass cut in automobile accident. Immediate nerve and tendon suture elsewhere; primary

union but with incomplete restoration of function. Secondary nerve and tendon suture 6 months after injury. a Before operation. b Result 12 months after operation.

without suture material threaded through the central portion—the core as it were—of the tendons. Sutures so placed these workers have found act as irritating foreign bodies at the very site where rapid and unimpeded proliferation of tendon and sheath tissue should go on if prompt and firm union is to take place.

If all the tendons are matted together at the site of division and the operation is a tedious and difficult one we do not always separate the individual tendons of the superficial group and of the deep group to the four fin-

gers from one another. In children, particularly, we have sometimes sutured the four superficial tendons above *en masse* to their respective tendons below, as though we were dealing with a single tendon, and have united the four deep tendons in the same way. In such cases we have still secured excellent results as far as individual action of the fingers is concerned (13, 14). If healthy clean-cut tendon ends cannot be approximated, and the tendons can only be brought together by utilizing the strands of fibrous tissue which have bridged the gap between the ends of the divided tendons, these strands are united by side to side union with fine silk sutures (Fig. 10c). If the latter method cannot be utilized, tendon grafts are taken from the foot to bridge the defect.

After the tendons are sutured the scarred nerve ends are amputated in successive thin

With a blood pressure apparatus and the manometer inflated and with constriction mal tourniquet the wound is free without the pressure bandage applied over the wound. A suture of the nerve is secured by say of our own on the net suture with a fine silk suture particularly with regard to nerve healing and tissue of the nerve. The swelling and the wound then when we it up to the net suture with the use of constriction with a suture bandage and a part of the operation.

Again, we repeat, we refer to the primary suture of the nerve and the constriction of the wound. The suture of the nerve and the constriction of the wound are the same as the suture of the nerve and the constriction of the wound.



Fig. 18a.

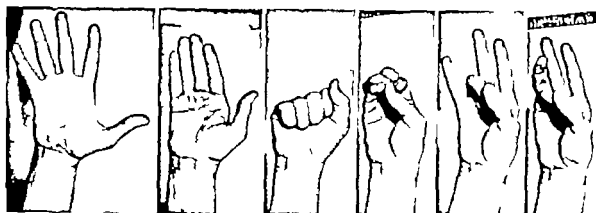


Fig. 18b.

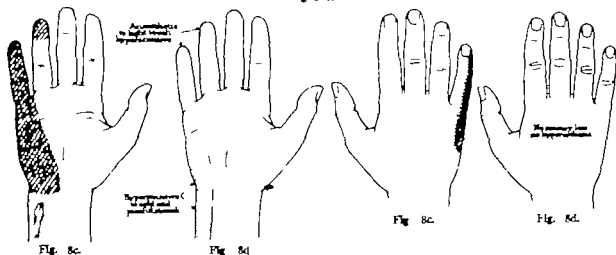


Fig. 8. Division of ulnar nerve and several flexor tendons as result of fall through glass door. Immediate tendon suture elsewhere, primary union. Suture of ununited ulnar nerve one year after injury: suture line protected with fat transplant from abdominal wall primary union. a. Before operation. b. Result 3 months

after operation, with ability to abduct and adduct fingers. Sensory findings before operation. Dotted area indicates extent of loss of response to light touch, oblique lines loss of response to pin prick. d. Sensory findings 3 months after operation. Restoration of function rapid in view of time elapsing between division and suture of nerve.

slices until healthy nerve ends are reached. The nerves are united end-to-end by very fine silk sutures which include only the epineurium (Fig. 15).¹¹

In the light of our present knowledge and as the result of our experience with three cases in which extensive gaps in nerves were bridged with fascial tubes, we have not felt justified in attempting any other methods of repairing divided nerves.

The value of plastic procedures or of nerve transplants to bridge a gap between divided nerve ends is still a controversial question. Two aspects of the subject we believe have not received the attention they deserve. The experimental work of Huber, Lewis, Corbett, Stookey, and Roberg on the use of nerve transplants was carried out on healthy animals; a segment of normal nerve was excised and immediately replaced by some type of graft. In only a few cases on record has a similar procedure been carried out in man. In the great majority of cases in which nerve transplants have been performed in man, a considerable interval of time has elapsed between the injury and operation, with resulting atrophy of all the tissues innervated by the divided nerve and degeneration of its distal segment. Not infrequently there has been severe wound infection and extensive scar tissue formation as well. Under

Many technical details have been emphasized with regard to the exact method of nerve suture. The essentials are delicacy of handling and the avoidance of trauma; accurate suturing without tension; the use of a minimally absorbent foreign material to favor the production of fibrous tissue; and the proper protection of the parts afterward. Valadier.

Catgut and especially the tension catgut sutures of Gossow, so generally used, we have carefully avoided after observing the absorptive reaction and disintegration produced by the catgut used abroad, and the absence of reaction from fine silk. Halbeck and Flower.



Fig. 19. Aluminum splint for maintaining volar flexion at the wrist after suture of the ulnar nerve.

such conditions the problem is obviously a different one from the transplantation of a healthy living nerve graft or of a preserved graft into normal tissue to replace a newly made defect in a normal nerve. In the second place, as Pollock has so clearly shown, careful discrimination must be used in interpreting the clinical symptoms present after operations on nerves. One must be particularly careful not to confuse the residual sensibility due to overlap of adjacent nerves with return of sensation due to nerve regeneration and not to confuse supplementary movements and re-education of normally innervated muscles with return of motor function in muscles supplied by the divided nerve.

With reference to the value of nerve transplants or of plastic operations on nerves, Lewis stated (41):

I believe that I have two cases in which there are decided evidences of return of function after the use of the auto-cable transplant. Nine years later he stated (42): "Accurate end-to-end suture gives the best results and should be performed in all cases when possible and a number of different procedures have been employed to bridge a defect in a peripheral nerve so long that an end-to-end suture cannot be made." Fdinger introduced the formalized calves' arteries. Tubes of Cargile membrane, fascial tubes, and decalcified bone tubules have all been used. Occasionally a success has been reported.

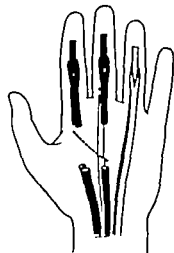


Fig. 20.



Fig. 20a.

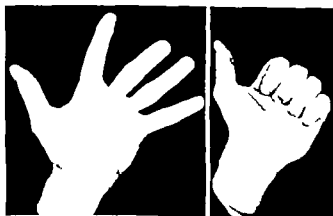


Fig. 20c.

Fig. 20. Division of flexors of index and superficial flexor of middle finger as result of porcelain faucet injury. Immediate tendon suture elsewhere; primary union without functional improvement. Secondary tendon

suture 6 weeks later; primary union. a. Before operation. b. Findings at operation. Solid black lines indicate divided tendons. c. Result 6 years after operation with complete restoration of flexion at both interphalangeal joints.



Fig. 21a.

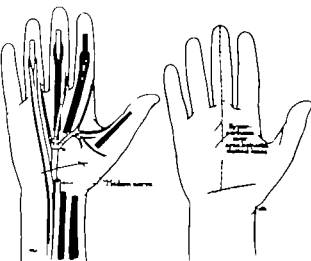


Fig. 21b

Fig. 21d

tary movements should be considered. These procedures cannot be depended upon and should be discarded.

The transplantation of segments of nerves has been attempted from time to time auto- homo- and hetero-grafts being used. Eden, for example, removed the tibial nerve in the case of an amputation and transplanted it into a defect in the musculospiral measuring 20 centimeters. After two years there was no improvement. Transplantation of segments of nerves has been repeatedly attempted with almost uniformly bad results. Occasionally a success has been reported. In some of the cases which have been operated upon the second time some neurofibrillae have been found in the transplant but they have not progressed far.

"Cable transplants have been tried without much success. Segments of nerves preserved in alcohol, as suggested by Nageotte, are not successful.

"Tubulization and grafts experimentally employed have given a great deal of information con-

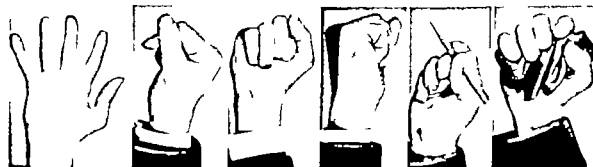


Fig. 21c.

Fig. Division of median nerve, flexor pollicis longus, both flexors of index and superficial flexor of middle finger as result of deep cutting wound of palm from a broken portulaca faurei. Immediate operation elsewhere; healing by primary union, but without recovery of function.

Secondary nerve and tendon suture 3½ months after injury. Primary union. a. Before operation. b. Findings at secondary operation. Solid black lines indicate divided tendons. c. Result 3 months after operation. d. Sensory findings 3½ years after operation.

after the employment of some such procedure. In such cases, however the possibility of double nerve supply of the muscle or muscles and of supplemen-

cerning the methods of repair in peripheral nerves but the results thus obtained cannot be applied directly to man."

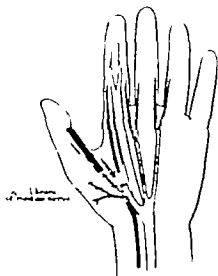


Fig. 22a



Fig. 22b

Fig. 22 Division of flexor pollicis longus and digital nerves to cleft between thumb and index as a result of a porcelain faucet injury. Immediate closure of skin, followed, by hematoma formation and slight wound discharge for 10 days. Secondary nerve and tendon suture 5 weeks after injury. Primary union. a Findings at operation. Solid black lines indicate divided tendon. b Result 4 months after operation.

Delageniere in discussing the surgical repair of peripheral nerves in the light of the results obtained in 3,5 wounded men stated that in 94 cases "incorrect sutures were performed. In 8 of these the gap between the nerve ends was bridged with strands of catgut. In 8 the nerve was partially divided and reversed. In 3 the two living ends of the nerve were anastomosed with an adjacent nerve. All of these operations resulted in failure. In 65 cases in which the resection of one or both ends of the nerve was insufficient there were 22 failures. With reference to "distant suture (bridging a gap with strands of catgut) tubular suture (bridging a gap with a tube of autoplasmic or heteroplasmic substance) and neuroplastic methods he says: "No good results have followed these procedures. With reference to autotransplants he says: "I have used the autoplasmic graft with some results. I took portions of the musculocutaneous nerve of the leg. I have had a complete recovery with the radial nerve and two very fair results with the ulnar. How can we explain these results in the case of the ulnar which is a mixed nerve? Whatever the explanation may be it has been proved true that by means of grafting fragments of the musculocutaneous nerve of the leg as long as 13 centimeters the peripheral nerve has recovered its function."

Bunnell reported very striking results following nerve transplantation—6 successful results in 6 cases.

Stokey has summed up the situation admirably.

When all procedures to obtain end-to-end approximation have failed, and a nerve defect remains to be bridged, there is only one method which has shown promise, histologically and experimentally, namely cable transplants of autogenous

nerve segments. The experimental evidence presented by such painstaking investigators as Huber (1895-1918) §Cajal (1918) and others has been so overwhelmingly in support of this method that it cannot readily be discarded. Clinically, however, the percentage of failures is very great. This pronounced difference between the clinical and the experimental evidence must be considered.

Clinically transplantation has been used as a last resort when all other procedures have been abandoned. Under such circumstances the defects

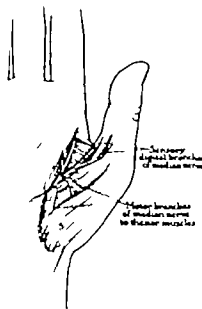


Fig. 23. Dissection showing the position of the motor branches of the median nerve to the thenar muscles.



Fig. 24a.

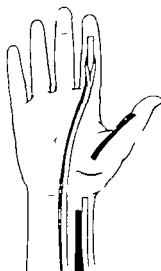


Fig. 24b.

Fig. 24. Division of flexor pollicis longus as result of glass cut in a 4 year old child. Immediate operation elsewhere with unsuccessful search for proximal segment of divided tendon, healing without infection. Secondary operation 7 weeks later with end-to-end suture of divided tendon. a. Before operation. b. Flaps at operation. Solid black lines indicate divided tendon. c. Result 2½ years after operation.

to be bridged are unusually long and in many instances the nerve grafts are placed in a dense scar bed. Often interstitial sclerosis in both the central and distal segments of the nerve is present. Under such circumstances successful regeneration by any method, even end-to-end suture, an infinitely simpler method, requiring less skill and fastidiousness, would be seriously jeopardized.

"Many failures are to be attributed to faulty technique rather than to the method itself.

"In view of the above facts, there is little wonder that nerve grafts are generally considered of no clinical value. Scattered through the literature, however, are quite a few reports of successful regeneration following the use of transplants, among them those by Gosset Delagènière, André-Thomas, and Villandre, Forrester Brown, Joyce, Frazer and Stooker. These reports show that clinically nerve defects can be bridged by nerve transplants, thus supporting the foundations laid and the conclusions

drawn from experimental work. In view of this and of the sound principles involved, it would seem expedient not to condemn this method as yet."

Care is used not to rotate either segment of the nerve in approximating the divided ends.

Stoffel and his followers emphasized the importance of such care in order that corresponding funiculi of the divided nerve segments might be brought into exact apposition and that sensory and motor fibers above might be brought into contact with sensory and motor fibers below. The anatomical studies of Heinmann, Borchardt and Wjasmen ski, Langley and Hashimoto, and others, however showed that "a definite funicular arrangement is found only within a short distance of the point at which nerve branches are to be given off" (Stooker) and that because of the many internal plexuses present in the peripheral nerves "the motor paths lie more or less constant only a short distance from the

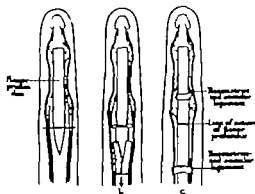


Fig. 25. Method of utilizing the slips of insertion of the flexor profundus to form an annular ligament to hold the sutured flexor profundus in apposition with the volar surface of the finger and of holding the flexor profundus in apposition with the volar surface of the proximal phalanx.



Fig. 26a.

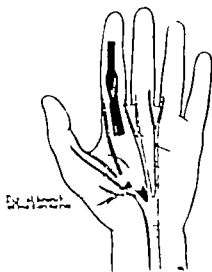


Fig. 26b.



Fig. 26c.

Fig. 26 Division of the flexor tendons of left index and of overlying digital nerves from a porcelain faucet injury. Immediate operation elsewhere with primary union but without restoration of power of flexion. Secondary nerve and tendon suture 3 months after injury. Both superficial

and deep tendons united end-to-end; remains of lumbrical muscle laid between the two tendons to prevent adherence to one another. a. Before operation. b. Findings at secondary operation. Solid black lines indicate divided tendons. c. Result 2 months after operation.

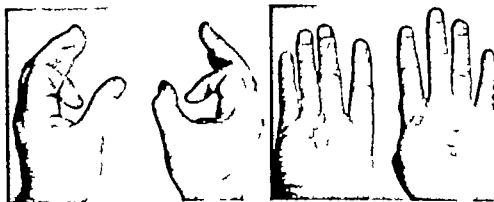


Fig. 27 Division of flexor profundus tendon of right index finger opposite the distal interphalangeal joint. primary suture under gas and ether anesthesia 24 hours after injury. primary union. Result 2 years after operation.



Fig. 15b.

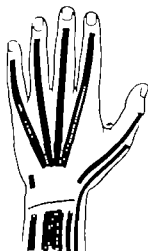


Fig. 15a.

Fig. 15. Division of extensor pollicis longus, extensor indicis proprius, extensor communis digitorum, and extensor carpi ulnaris as result of fall through glass window. Tendon suture under local anesthetic 5 hours later primary union. a. Findings at operation. Solid black lines indicate divided tendons. b. Result 7 months after operation.

point at which they leave the nerve stem (Borchardt and Wjaszowski). Huber as a result of experimental studies stated: "I am confident that it is not necessary in practical work to give undue stress to Stöfel's studies on the specific funicular structure of nerves. Any one who has worked experimentally with regeneration of nerves realizes that from 10 to 50 new neuraxes may bud toward the periphery from a single central neuraxis, and 15 or 20 new neuraxes are often found centrally in a single old neurilemma sheath. No matter how carefully primary suture is made, there is a great tangle of these new nerve fibers as they pass through the connective tissue of the wound, and especially is that the case with secondary sutures. A large number of fibers pass from the stump along the transplant in the connective tissue surrounding the transplant. I am sure sensory nerve fiber branches reach the motor nerves and that central motor nerves reach the distal sensory nerves and are maintained for a time. They make no distal connection and in time degenerate."

The nerve suture can sometimes be facilitated by inserting a temporary suture through the nerve sheath on the under surface of each segment about an inch from the point of division. Traction on the two sutures helps to draw the nerve ends together and relieve tension while the permanent sutures are inserted.

If the first suture is placed at the very center of the posterior or deep surface of the nerve and a second and third suture inserted at either side of the first suture before the first suture is tied accurate apposition is facilitated. If there is some tension on the nerve ends it is difficult to secure accurate apposition over the deep or posterior surface if the suture is begun on the anterior or superficial surface.

If fat from the subcutaneous tissues at the site of operation can be obtained to separate the deep from the superficial tendons and to protect the lines of nerve suture this is utilized. If not, fat is taken from the abdominal wall and very thin layers of fat laid between deep tendons and carpal tunnel, between deep and superficial tendons and about lines of nerve suture.¹⁹

Conflicting ideas have been expressed concerning the use of fat transplants about severed tendons and nerves. The recommendations of the older Ebers in this respect are well known. Huber reported an experiment in which subcutaneous fat was wrapped around a nerve transplant; in 35 days the fat sheath was entirely replaced by dense connective tissue. This agrees strongly against fat sheaths in peripheral nerve repair. This conclusion, however, was made on the basis of single experiments.

Later Huber stated, "There is one more point I should like to refer to in connection with our experimental work, namely the importance of having dry clean wounds, before the wound is closed. There would appear to be a correlation between a field not quite dry and an increase of connective tissue about the nerve operated upon. It is our belief that the latter point is the important one so far as the formation of connective tissue is concerned."

Little has said, "After the nerve is completed the nerve should be placed when possible in a new muscle bed. The direction should be

Finally the deep fascia and subcutaneous tissue are approximated as accurately as possible with fine silk sutures the skin edges carefully approximated and a massive gauze dressing bandaged snugly in place. Only when the bandage is in place is the air released from the constricting cuff. Since using this method of maintaining a bloodless field we have never found it necessary to open a wound to let out accumulations of blood and have invariably found our wounds soft and free from tension when the primary dressing was changed.

Usually it is necessary to apply a splint to maintain flexion at the wrist for a time and so eliminate tension on sutured tendons and nerves (Fig. 19).²⁰ If flexion at the elbow is necessary to give relaxation of the sutured nerves the splint is designed so as to include the elbow as well.

Active and passive movements of the fingers which do not cause tension upon the line of skin suture are begun at the first change of dressings twenty-four hours after operation. As soon as the superficial wound is healed sufficiently so that more extensive movements can be carried out without danger of separating wound edges active movement and physical therapy are begun and continued daily. The length of time during which flexion at the wrist is maintained depends upon the degree of flexion that has been necessary to permit approximation of tendons and particularly of nerves, without undue tension. The flexion splint is gradually straightened during the second and third week and removed in all cases by the end of the third week.



Fig. 20. Preferred incision for exposing divided extensor tendons over the dorsal surface of the wrist.

INJURIES OF THE PALM (Figures 20 21 22 24 26 40)

The line of incision depends to a certain extent upon the position and extent of the original injury. Four general principles should be kept in mind. An adequate incision reduces operative trauma, the attempt to free important structures from surrounding adhesions by subcutaneous dissection is frequently unsuccessful and often leads to futile and unnecessary prolongation of the operation. Second, the incision should follow if possible the normal flexion creases of the palm.²¹ Third, the incision can often with advantage be planned so that the old scar is excised. Finally, the blood supply of skin flaps must be given due consideration, and any modification of that blood supply which may have resulted from the original injury. As with injuries at the wrist it is very desirable to have a flap of skin and subcutaneous tissue to lay over the line of nerve and tendon suture so that normal tissue may cover the site of repair of nerves and tendons.

After the skin incision is made and the site of injury exposed one must first isolate the

made when possible along intermuscular septa so that the muscle fibers of these muscles which may later be needed to form the new bed for the nerve are not cut. It is not necessary to use any of the numerous methods to cover the suture line which have been advocated.

We believe, however, that there is a logical basis for the use of a preexcised or free transplant of about a sutured tendon or nerve for loose areolar tissue and fat are normally present about these structures, with the exception of those portions of the tendons which are surrounded by definite synovial sheaths. At the wrist or in the hand it is impossible to place the sutured nerves or tendons in a new muscle bed. There is no muscle available. Moreover, it has not often been possible in our experience with nerve suture above the wrist to place the sutured nerve in a bed of muscle without dividing muscle fibers obliquely, and bringing about some bleeding at the site of division. All of our experience confirms Huber's statement, quoted above, that there is a definite relation between the degree of the operative field at the close of operation and the amount of subsequent scar tissue formation.

²⁰ Physiologists have shown that the union of a sutured nerve occurs soon, but is not firm until after four weeks. After this period a sutured nerve cannot be torn off by the normal motions of limbs, even if it was severed in flexion, and there is no danger in putting the limb through gradual progressive movements of extension. DeGardner.

²¹ Many fingers are permanently crippled by the median longitudinal incision. If the median longitudinal incision of the finger, whether on the dorsal or the palmar surface, through the matrix or in the pulp, whether for infection or repair, be eliminated entirely from the surgeon's activities, many fingers will be saved from being permanently damaged. Even in the palm the longitudinal incision leads to contraction. It is far better to make transverse incisions! The palm is the line of the creases or L-shaped ones than longitudinal. Bennett (1).

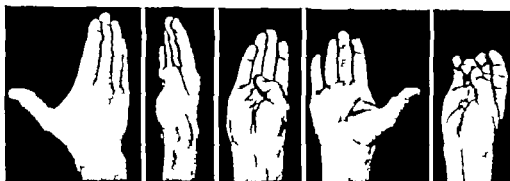


Fig. 30b.

Fig. 30. Division of extensors of radius, both extensors and long abductor of thumb, and of superficial branch of radial nerve as result of razor cut. Immediate closure of wound with clips. Tendon suture else where 6 days later primary union without functional result. Secondary nerve and tendon suture 3½ months after injury primary union. a. Findings at operation. Solid black lines indicate divided tendons. b. Result 3 months after operation.



Fig. 30a.

digital nerves. These small nerves control the motor function of the lumbrical and thenar muscles, sensation in the palm and fingers, and trophic function of the innervated muscles and in the area of sensory distribution. They lie just underneath the palmar aponeurosis and slightly superficial to the tendons. They are usually bound tightly in the fibrous tissue which holds aponeuroses, nerves, blood vessels tendons, and sometimes overlying skin in a mass of scar tissue. Unless they are sought and recognized at the very beginning of the operation they may be hopelessly damaged or even remain unrecognized. In these operations there is no royal road. As with injuries at the wrist one must find the nerves above and below the site of injury and trace them from normal tissue into scar tissue. Of particular importance is it to recognize and guard from injury the motor branch of the

median nerve to the thenar muscles, to free it from scar tissue and suture it if divided. The paralysis of the thenar muscles which results from its division and the resulting loss of ability to rotate the thumb so that it faces the fingers are important elements in the loss of function resulting from median nerve injury. The nerve usually appears as depicted in Figure 23 and leaves the sensory digital branch to the ulnar side of the thumb at a level close to the middle of the first metacarpal bone.

Of equal importance is it that the digital blood vessels which accompany the digital nerves should be guarded from injury. Failure to do so may result in necrosis and gangrene of one or more fingers. We have not hesitated to divide the superficial palmar arch if necessary to secure adequate exposure or facilitate removal of scar tissue, but whenever possible it has been left intact.

After nerves and blood vessels are freed and protected from injury the tendons must be found. Frequently the divided ends will have retracted a considerable distance from the site of injury and may be difficult to find. Because it lies in a separate sheath and so does not become adherent to the adjacent tendons, the proximal segment of the divided flexor pollicis longus, particularly is likely to retract into the forearm and it may be necessary to follow it to a level above the wrist, or to make a separate incision above the wrist in order to locate it (Fig. 24). Often in searching for the proximal segment of a divided flexor tendon it is possible to distinguish the thin fibrous tissue remains of the empty sheath or of the areolar tissue which surrounded the tendon in the

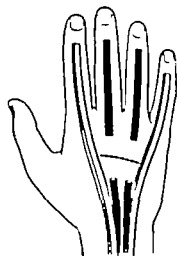


Fig. 31a

Solid black lines indicate



Fig. 31b

Fig. 31. Division of extensor tendons of middle and ring fingers by trepan & axc. immediate wound closure elsewhere without tendon suture. Secondary tendon suture 7 weeks after injury with tranplantation of fat under sutured tendons. primary union. a Findings at operation. b Result 4 years after operation.

palm. By putting tension upon this tissue the end of the tendon can be drawn downward in to the wound. The tendon itself is recognized through its covering of areolar tissue by the yellowish tinge at the edge of the cut tendon which is now more or less completely fused with the surrounding connective tissue. This fusion definitely limits its movement but if the adherent areolar tissue is completely excised by sharp dissection free movement of the tendon is again made possible.

In locating and freeing the distal segments of the divided tendons care must be taken to preserve if possible the fibrous tendon sheath or enough of it to act as an annular ligament opposite each phalanx. If this is impossible new annular ligaments must be constructed after the tendon repair is completed.

The problem of uniting tendons which have become widely separated is sometimes a difficult one. If both superficial and deep tendons cannot be approximated without undue tension, the distal stump of the superficial tendon can be excised and a part of the proximal segment utilized as a free graft to bridge the gap between the retracted ends of the deep tendon. In such cases one of the slips of insertion of the sublimis may be left attached at its insertion, laid transversely across the profundus and the free end sutured on the opposite side to the fibrous tissue remains of the flexor sheath, so as to form a new annular ligament to hold the deep tendon in place (Fig. 25).²²

²² One of the great difficulties (in tendon transplantation) is to provide

A thin segment of tendon may also be laid across the deep tendon at the middle of the proximal phalanx and sutured on each side to the remains of the fibrous sheath so as to form a new annular ligament at the level of the web (Fig. 25c) or as Bunnell has suggested a strip of tendon or fascia may be passed around the proximal phalanx underneath the extensor tendon so as to encircle the bone and the flexor tendon. With the ends sutured rather snugly a firm annular ligament is formed to hold the tendon in place over the volar surface of the bone.

If it is possible to bring proximal and distal segments of both superficial and deep tendons to a finger together in the palm without undue tension, the question arises as to the wisdom of having two lines of suture at the same level and in close approximation and whether the two sutured tendons will not adhere to one another and so fail to move freely. We have sometimes met this problem by laying the lumbrical muscle between the two tendons at the line of suture and holding it in place by one or two fine sutures. Figure 26 shows the result obtained in such a case in which both flexors of the index finger and the digital nerves to adjacent sides of the thumb and index had been divided just below the level of the outstretched thumb.

After the tendon repair is completed the

phalangeal annular ligaments where they have been destroyed so as to prevent tendon prolapse. If the flexor sublimis tendon has its dividing slips along the side available, it is possible to use these. If not, it may be necessary to transplant fascia. Anchiolosis (3)

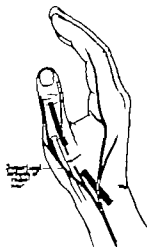


Fig. 32.

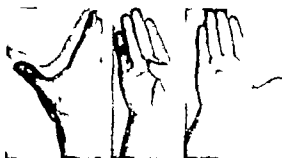


Fig. 33b.

Fig. 32. Division of extensor pollicis longus and digital nerve to ulnar side of thumb from pocket knife injury. suture of skin elsewhere 12 hours later healing slow complete in 3 months. Secondary tendon and nerve suture 8 1/4 months after injury—primary union. a. Findings at operation. Solid black lines indicate divided tendon b. Result 1 year after operation.

divided nerves must be sutured. In the hand this is often more difficult than at the wrist, for not uncommonly it is necessary to suture two or three small branches below to the larger nerve trunk above. Bunnell has suggested that in such a case the small distal segments may with advantage be gathered into a single bundle by a circular suture before end-to-end suture is performed. The necessity of removing sufficient scar tissue to expose healthy nerve fibrils results in a gap of varying extent between proximal and distal segments. This gap can usually be bridged by freeing the proximal segment above and gently drawing it downward and by flexing the fingers at the metacarpophalangeal joints. Freedom from tension on the line of nerve suture and particularly upon the small and delicate distal segments (the digital nerves) is essential for success.

The use of a thin flap of fat to separate sutured tendons and nerves from overlying skin and to protect the line of nerve suture is helpful in securing a successful result. If subcutaneous fat can be secured at the site of operation it is always utilized, otherwise fat is secured from the abdominal wall.

INJURIES OF THE VOLAR SURFACE OF THE FINGERS

Although tendon division may occur at any point along the volar surface of the proximal and middle phalanges the most common site

of injury of the tendons within the fingers is at their base, approximately at the level of the web. At this level there are three tendons within the flexor sheath—the two halves of the flexor sublimis, separating from one another and passing toward their insertion on the base of the middle phalanx and the single tendon of the flexor profundus passing underneath the dividing sublimis toward its insertion on the base of the distal phalanx.

In operating upon such cases in earlier years we made the mistake of attempting to suture all the divided structures, and to bring about a complete anatomical restoration. This was always difficult, because the distal slips of the flexor sublimis were invariably short and because they were thin and flat, or slightly crescentic in cross section. Furthermore the suture of three distinct structures at the same level tended to bring together a considerable mass of sutured tissue in a comparatively small space, with the result that the formation of adhesions between deep and superficial tendons was favored and the gliding movement of the tendons impeded.

Bunnell's successful results following the transplantation of a single tendon into a finger from which both flexor tendons had been removed showed that a single tendon attached to the distal phalanx is adequate for maintaining the function of flexion. In cases in which the flexor tendons were divided between the level of the metacarpophalangeal joint



Fig. 33a



Fig. 33b



Fig. 33. Subcutaneous rupture of extensor tendon of middle finger. a. Findings at operation. b. Result 1 year after operation.

and the base of the middle phalanx we therefore began to depend upon the suture of the profundus alone and to utilize the slips of insertion of the flexor sublimis in the construction of a new annular ligament to hold the profundus in place opposite the middle phalanx. This plan of procedure gave more satisfactory results than the former method but the results of suture of the tendons within the fingers are still far from perfect and are less satisfactory than those of tendon suture in any other location.²³

As with injuries in the palm the operative incision is made in such a way as to avoid cutting across the normal folds and creases of the skin, usually along the most accessible lateral surface. The digital nerves and vessels are sought first of all and are carefully protected from injury during the course of operation. The tendon sheath is opened widely enough to expose the tendon ends and free them completely from the adhesions which fix them and to permit careful and accurate suture. Occasionally it is possible to preserve enough of the sheath opposite the proximal and opposite the middle phalanx to act as an annular ligament and hold the sutured tendon in apposition to the phalanges during flexion. Usually, in our

experience this is not possible. Too often as a result of the infection and fibrous tissue formation which followed the primary injury, even though the infection has been minimal, the tendon and the sheath in which it glides freely under normal conditions are converted for some little distance from the site of injury into a solid cord of fibrous tissue. The portion of the sheath left empty by retraction of the ends of the divided tendon collapses. Although at times it may be possible to open the sheath and free the tendon within it, rarely is there sufficient space within the sheath for the sutured tendon to glide freely. Under normal conditions the tendon is held snugly by its sheath. If the tendon is thickened as a result of injury and the insertion of even fine suture material, there is simply not sufficient room for the tendon to move freely.²⁴ Moreover as a result of the injury the lining walls of the sheath are no longer smooth shining surfaces but are dull and fibrosed. Such conditions favor reformation of adhesions and militate against free movement. We have usually therefore found it necessary to excise the remains of the tendon sheath at the site of injury so as to provide adequate space for the thickened tendon and to depend upon early

²³ There are two reasons for this fact: the rapidity with which adhesions form in the finger about the sutured tendon and the relatively poor blood supply of tendons surrounded by synovial sheaths. Al. von S. and Shearson has shown in their experimental work on tendon suture that the blood supply of the tendon is an important factor in healing, and that sutured tendons surrounded by loose and vascular areolar tissue heal more rapidly and firmly than tendons enclosed in a synovial sheath, and which depend for their blood supply chiefly upon small blood vessels such as are present in the vincula tendinum of the flexor tendons to the fingers.

²⁴ A striking illustration of this fact is the condition known as a snapping finger. Following a comparatively slight injury, such as a sudden pull applied to a flexed finger or sudden hyperextension of an extended finger, the patient complains of localized pain and subsequently develops a "snap." This is an interference with complete flexion or complete extension which occurs at a definite and constant point in the arc of movement. At operation there is often found a spindle-shaped enlargement of the tendon just distal to the proximal termination of the flexor sheath in the palm, and this enlargement, though slight, is sufficient to interfere with the free gliding movement of the tendon in its sheath.

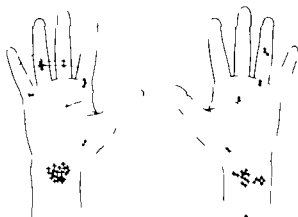


Fig. 34.

Fig. 35.

Fig. 34. Nerve and tendon injuries of the volar surface of the right hand and forearm (the marker indicates the site of injury; + indicates division of both nerves and tendons, O of tendons alone.)

Fig. 35. Nerve and tendon injuries of the volar surface of the left hand and forearm (the marker indicates the site of injury; + indicates division of both nerves and tendons, O of tendons alone.)

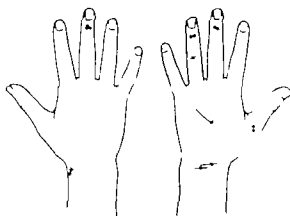


Fig. 36.

Fig. 37.

Fig. 36. Nerve and tendon injuries of the dorsal surface of the right hand and forearm (the marker indicates the site of injury; + indicates division of both nerves and tendons, O of tendons alone.)

Fig. 37. Nerve and tendon injuries of the dorsal surface of the left hand and forearm (+ indicates division of both nerves and tendons, O of tendons alone.)

movement to prevent the formation of adhesions and fixation of the tendon to the surrounding soft tissues.

The utilization of the slips of insertion of the *sublimis* tendon as a substitute for the fibrous flexor sheath opposite the middle phalanx has been mentioned. A simple plan consists in the utilization of a single slip which is left attached at its normal insertion and laid transversely across the *profundus*; its free end is sutured with fine black silk to the fibrous expansion of the extensor tendon at the side of the finger. A short strip of tendon may be laid in the same way across the *profundus* opposite the middle of the proximal phalanx and sutured to the fibrous tissue on either side to form a retaining ligament opposite the point of greatest stress (Fig. 25).

If the deep tendon alone has been divided beyond the point of insertion of the flexor *sublimis* (Fig. 29) suture may be rendered difficult because the distal stump is short and almost inaccessible for accurate suture from a lateral incision. It is in such cases particularly that an incision in the shape of an inverted L (I) with its transverse limb at the distal flexion crease of the finger, may be helpful. In such cases one must also be certain that the remains of the fibrous tendon sheath does not form a

barrier to the full movement of the tendon as it is drawn upward by contraction of the flexor muscle or that the new annular ligament if one is provided does not form a similar obstruction.

Finally after tendon repair is completed the digital nerves, if they have been divided are united by end to-end suture.

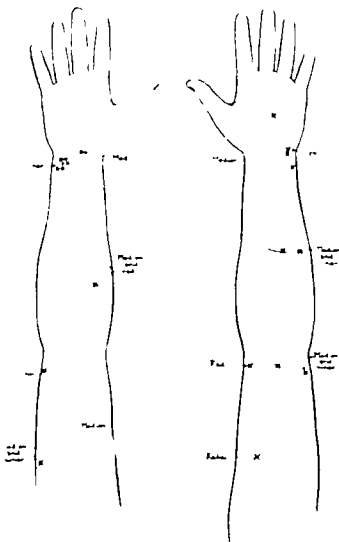
INJURIES OF THE DORSUM OF THE HAND (Figures 5 28 30, 31 32 33)

While injuries of the dorsum of the hand with division of the tendons and nerves may occur at any point the majority of them are included in one of four groups: (1) injuries on the dorsum of the wrist with division of the extensor tendons of the four fingers; (2) injuries on the radiodorsal surface of the wrist with division of the long abductor of the thumb and the extensors of the thumb and wrist; (3) injuries on the dorsum of the metacarpus; and (4) subcutaneous rupture of the extensor tendon opposite the distal interphalangeal joint. With tendon injuries included in the first three groups there may be division of one or more of the sensory branches of the radial or ulnar nerves.

Injuries on the dorsum of the wrist frequently result in a division of the extensor

digitorum communis with or without concomitant division of the extensor indicis proprius, extensor digiti quinti proprius and extensor carpi ulnaris (Fig. 35). The fact that the first of these passes underneath the dorsal carpal ligament through the same compartment as the extensor digitorum communis makes it almost inevitable that it should be injured if the common extensor is divided. Common characteristics of these injuries are the marked retraction of both segments of the divided tendons and the fact that usually both proximal and distal segments are firmly matted together by scar tissue for some distance from the point of division. Since a muscle relieved of its normal tension immediately contracts to the resting stage, the proximal segments of the divided tendons retract upward into the forearm. Because the flexor muscles are more powerful than the extensors and since the normal position of the relaxed hand is with the fingers in semiflexion, the distal segments of the divided tendons are drawn distalward with the result that the gap between the divided ends is even greater than it is ordinarily after tendon division. Too often the advantage of splinting the injured hand in the position of dorsal flexion immediately after injury has been overlooked and an additional degree of avoidable separation has taken place.

In the operative exposure of such injuries a crescentic or a flap incision (Fig. 20) with its center opposite the site of injury has several advantages. It permits one to lay a flap of fairly normal skin and subcutaneous tissue over the sutured tendons. It may make it possible to avoid entirely cutting across the healed scar and so make more certain primary healing of the operative wound. It facilitates closure of the incision when the wrist is held in dorsal flexion. If on the other hand one makes a vertical incision along the midline of the forearm and directly across the scar, dorsal flexion of the wrist forces the edges of the incision apart and renders closure of the wound extremely difficult. Too often such an incision fails to heal at the site of greatest tension where the operative incision crosses the scar of the original injury; the wound begins to gape, and tissue necrosis and wound infec-



Figs. 34 and 35. Left, nerve injuries of right upper extremity; right, nerve injuries of left upper extremity. In these cases, either a nerve only was injured or the co-existent tendon injury had been repaired elsewhere at the primary operation.

tion take place, with the result that healing is delayed and the ultimate result definitely impaired.

In making the operative incision and raising the flap it is necessary to remember that the sensory nerves lie just underneath the subcutaneous tissue, superficial to the deep fascia overlying the tendons. As in operations elsewhere on the hand the nerves must be recognized and isolated at the outset of the operation or they will be irreparably injured.

Before the divided tendons can be united it is necessary to free them from the surrounding scar tissue to such an extent that a pull applied directly to the proximal segments draws them well down into the field of operation, and a pull applied to the distal segments

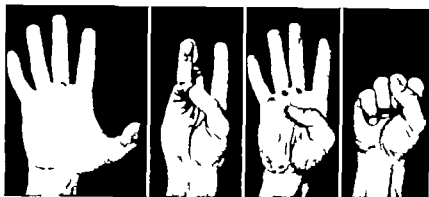


Fig. 40. Division of flexor pollicis longus. Tendon suture 48 hours after operation followed by infection of tendon sheath and radial bursa. Result 4 years after operation.

produces complete extension of the affected fingers. It is not necessary and usually not wise to separate the tendons from one another and unite them individually they would simply become adherent to one another again. The operation moreover would be prolonged and rendered more difficult for the individual tendons are so narrow and slender that their approximation is much more difficult than that of a larger tendinous mass.

Infunes on the radiodorsal aspect of the wrist may cause a division of the abductor pollicis longus and extensor brevis, of the extensor pollicis longus alone, of all three tendons or of the three tendons and the underlying extensors of the radius (Fig. 30). If one remembers that the first two tendons pass under the dorsal carpal ligament through the compartment farthest to the lateral side and form the most marked prominence on the lateral aspect of the wrist, that the extensors of the radius pass through the next compartment and at a slightly deeper level and that the extensor pollicis longus passes through a third compartment still more medial and more superficial than the second, it is easy to understand why certain tendons are likely to be divided in certain types of injury either alone or characteristically in association with other tendons. If one keeps in mind this association he is not likely for example, to fail to find and unite the divided extensor brevis if the abductor longus has been divided or to look for injury of the extensors of the radius if the three more superficial tendons have been divided.

Infunes on the dorsum of the metacarpus may involve one or more of the extensor tendons of the fingers (Figs. 5-31). Because the individual tendons are united laterally by the oblique bands which pass between them and held to a slight extent by the areolar tissue which surrounds them retraction of the divided tendons is not so marked as after infunes on the dorsum of the wrist, for example and suture of divided tendons on the dorsum of the metacarpus is relatively easy. If after operation the fingers are supported on a cock-up splint, so that there is no tension upon the line of suture for a period of from ten to fifteen days, one should secure a perfect result in practically every instance.

Subcutaneous rupture of the extensor tendon opposite the distal interphalangeal joint (Fig. 33) was discussed by Mason in a paper published in this journal in March, 1930 and the operative treatment carefully described. As Mason pointed out the site of rupture is usually just opposite the joint. In cases seen immediately after injury the tendon may appear intact when first exposed, because the thin sheath of areolar tissue which surrounds the tendon is stretched but not divided. When this sheath is dissected free the ruptured tendon is exposed. In cases seen some time after injury the ends of the tendon are united in a lengthened position by a bridge of connective tissue which has formed within the sheath of areolar tissue. We have secured the best results by excising this thickened connective tissue and bringing the clean cut tendon ends into accurate apposition. If one simply divides



Fig 41a.

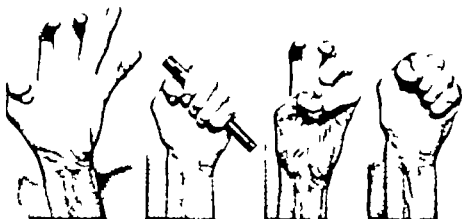


Fig 41b

the bridge of connective tissue and overlaps the two segments sufficiently to shorten the lengthened tendon suture is more easily carried out but a considerable mass of tissue is left under the thin skin of the distal phalanx which may interfere with healing of the skin and leave a tender and unsightly swelling at the site of suture.

In excising the bridge of connective tissue that has formed between the ends of the ruptured tendon, care must be taken to leave the greatest length possible attached to the distal phalanx. It is always difficult to be certain that the sutures inserted in the thin distal segment of tendon will not cut through and release their hold on the distal phalanx. The larger the slip of tendon left attached to the distal phalanx the less likely is this to happen.

In the after care of such injuries we have found it wise to splint the affected finger in complete extension or slight hyperextension at the distal interphalangeal joint for a period of two and one half or three weeks. For this purpose the familiar baseball splint of Lewin is very useful.

RÉSUMÉ OF CASES OF DIVIDED NERVES AND TENDONS

Since March, 1916 we have had the opportunity of operating upon 170 patients with division of the nerves and tendons of the hand.²⁵ Ninety-seven of these were from the service of Drs. Kanavel, Loyal Davis, Mason, and Koch at Wesley Memorial Hospital, 57 from the service of Drs. Mason and Koch at

Fig 41. Division in automobile accident of median nerve and all flexor tendons over volar surface of left wrist except deep flexor of little finger. Primary suture of nerve and tendons followed by severe spreading infection and extensive destruction of superficial and deep tissues.

Secondary suture of median nerve and flexor pollicis longus 16 months after injury. a Result after primary suture and subsequent infection (just before secondary operation). b Result 3 years after secondary operation. c Sensory findings 3 years after secondary operation.



Fig 41c.

Passavant Memorial Hospital, and 16 from the service of Dr. Koch at Cook County Hospital. In 70 cases tendons alone were divided in 31 cases nerves alone, in 69 cases both nerves and tendons.

In 134 cases the injury involved the volar surface of the forearm, wrist or hand, in 37 cases the dorsal surface. (In one patient the dorsal surface of the right hand and volar surface of the left were involved in the same accident.) The hand involved, the approximate location of the various injuries, the relative frequency of injury in different locations, and the relative frequency of associated nerve and tendon injury in different locations are indicated in Figures 34 to 39. The striking fact illustrated by these diagrams is the frequency of involvement of the volar surface of the wrist, the extent of such injuries, and the almost constant association of multiple ten-

²⁵ This does not include a group of 11 cases of nerve and tendon division in which it was impossible to approximate the divided tendons and in which the defects were bridged with tendon grafts.

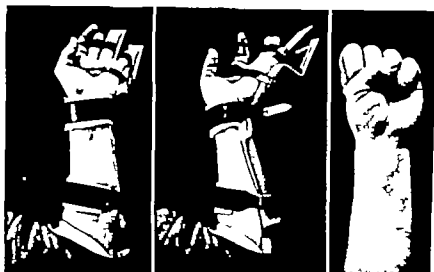


Fig. 42 Division of ulnar nerve and blood vessels, flexor carpi ulnaris and superficial flexors of four fingers; immediate ligation of blood vessels and suture of divided nerve and tendons under gas and ether anesthesia. Low grade infection of wound with sinus formation persisting for 6 months after operation. Result 8 1/4 months after operation.

don divisions with division of the median or ulnar nerve or both.

The age of the patients varied from 12 months to 60 years. Fifteen were between 1 and 5 years of age. 18 were in the first decade of life. 22 in the second. 63 in the third, 38 in the fourth. 22 in the fifth and 6 in the sixth. the age of one is unknown.

A brief discussion as to the immediate cause of injury the immediate treatment rendered and the immediate results obtained may be of some interest. In 166 cases the cause of injury was recorded. In 46 cases the injury resulted from a glass cut and in the majority of these cases the patient had fallen and

pushed his hand through a glass door or window. In 25 the injury resulted from an automobile accident and in the majority of such cases it was stated that the wound was caused by broken glass from a windshield or car door. In 23 cases the injury was due to a knife cut, a stab wound or razor wound. In 11 cases the injury resulted from a fall on a bottle, a glass tumbler or a cup with collapse of the object and a resulting penetrating wound. In 9 cases the injury resulted from collapse of the porcelain handle of a water faucet with subsequent laceration and penetration of the palm by a sharply pointed or jagged fragment of the handle. In 12 cases tendon



Fig. 43 Division of median nerve, long flexor tendons of thumb, index and middle fingers, immediate tendon suture elsewhere. primary union, unsatisfactory functional

result with inability to flex thumb and index completely or forcefully. Secondary nerve and tendon suture 5 years after injury. Result 17 years after secondary operation.

division was the result of subcutaneous rupture, in 2 cases the flexor tendon of a finger was involved, in 10 cases an extensor tendon opposite a distal interphalangeal joint. Other causes included gunshot and bullet wounds injuries from rip saws or circular saws lacerations from jagged steel fragments wire sharp edges of zinc and tin and crushing injuries.

Twenty two patients were seen by us with in from 10 minutes to 25 hours of the injury and were operated upon immediately two other patients one seen 36 hours after injury and one 48 hours after injury were also operated upon immediately. Of these 4 patients the operative wound healed by primary union in 15 cases wound infection developed in 7 cases, 2 patients did not return after operation and no record of the postoperative course in these 2 cases is available.

The 7 cases in which wound infection developed after immediate operation deserve particular consideration for it was primarily because of the infection which took place in these cases and the severity and duration of the infection in 4 cases (Cases 1 3 4 5) that we were forced to recognize the danger of immediate operation for divided nerves and tendons and that we have since laid so much stress on the importance of delaying repair of divided nerves and tendons unless one is certain that the wound is clean.

CASE 1 F P Wesley Memorial Hospital 11566 April 10-May 6 1924 (Fig. 40)

This patient a bottle inspector 33 years of age sustained a cut across the volar surface of the thumb at the level of the metacarpophalangeal joint from a broken glass jar April 8 1924. He received treatment from a physician for two days and was then sent to the hospital because of inability to flex his thumb at the interphalangeal joint. He was operated upon under local anesthesia shortly afterward approximately 48 hours after the injury. The some what ragged skin wound was enlarged, the ends of the divided flexor pollicis longus brought together with silk sutures and the skin wound loosely closed with silk worm gut and skin clips. Warm wet dressings were applied to the hand continuously after operation.

The morning after operation April 11 the patient's temperature had risen to 102 degrees and it was noted that there was edema redness and tenderness, particularly about the wrist and on the radial side. No pain on extension of the little finger, some pain and wincing on extension of the index and

middle fingers. On April 12 swelling of the wrist a little more marked. On April 13 swelling of the wrist forearm and dorsum of hand more marked redness and exquisite tenderness on radial side of dorsum of wrist. Between April 11 and April 14 the irregular temperature ranged from 98.6 to 103 degrees reaching the latter point on the afternoon of April 14. April 15 under nitrous oxide anesthesia the radial bursa was opened by extending the operative incision upward for 3 inches along the radial side of the forearm. A thin sanguino-purulent discharge was evacuated which showed a pure growth of staphylococcus (the report does not say whether albus or aureus) on culture. The following day it was noted. Thin seropurulent discharge around rubber tissue drain. Patient feels much better slept for first time last night.

The infection gradually cleared up and the patient left the hospital May 6 6 days after operation (tendon suture) with the wound healing but still requiring dressings.

CASE 2 V H Wesley Memorial Hospital 113096 114522 July 1 30 1924 September 18-23 1924

This patient a 33 year old carpenter received a long oblique deep cut of the left palm and wrist from a rip saw June 30. He was taken immediately to a hospital where the injury was treated and the wound sutured under ether anesthesia.

The following day he was transferred to Wesley Memorial Hospital and operated upon under gas and ether anesthesia shortly after admission. The wound extending from the cleft between the little and ring fingers to the base of the thenar eminence was opened widely, the median nerve all the long flexor tendons of thumb and fingers and the first metacarpal bone had been divided, no attempt had been made at operation the day before to repair these structures. The tendons and nerve were united and the hand splinted so as to immobilize the first metacarpal. The operation required 2 hours 5 minutes. Warm wet dressings were applied to the hand at the close of the operation and maintained continuously for 48 hours.

The afternoon following operation the patient's temperature rose to 101 degrees thereafter it gradually receded reached normal on the third post operative day and did not rise above 99.2 degrees thereafter. Although he complained of some pain in the hand there was very little postoperative swelling and for some days it appeared as though healing were taking place without infection. On the tenth postoperative day July 11 a slight wound discharge appeared between the little and ring fingers, two sutures were removed from this area and some thin seropurulent discharge escaped. The following day the dressings were fairly well saturated and it was noted that there was separation of the skin edges along almost the entire extent of the wound. Bridges of adhesive were placed across the incision to prevent further separation the wound was carefully dressed each day and by July 19 there was little

wound discharge. July 25 it was noted that there was still slight wound discharge at the base of the thumb. July 28 the wound was dry still edema on the dorsum of the hand 30 days after operation.

The patient left the hospital July 30, and returned daily for physical therapy. Sometime after leaving the hospital (the exact date is not recorded) a sinus appeared at the distal end of the wound between the ring and little fingers. Because of this he re-entered the hospital September 18. The sinus was curetted and warm wet dressings applied for 48 hours. He left the hospital September 23 and the wound discharge ceased completely shortly afterward.

CASE 3 U. S. Wesley Memorial Hospital, 184311
133054. March 31-May 24, 1926 July 26-
August 1, 1927

This patient a 16 year old piano student, was admitted to the hospital at 11 p.m. twelve hours after an automobile accident in which she had received a glass cut across the volar surface of the left wrist. The divided ulnar artery had been ligated with silk worm gut immediately after the injury. Operation was performed under local anesthesia the following morning, April 1 just twenty four hours after the accident. There was little swelling about the site of injury at the time of operation and no evidence of infection in the open wound. The median nerve and all the flexor tendons over the volar surface of the wrist except the deep flexor of the little finger had been divided. All were isolated. The wound was enlarged by a longitudinal incision, and the divided structures carefully sutured.

Twenty four hours after operation the patient's temperature had risen to 103.6 degrees and her pulse to 140. She complained of some pain in the forearm. The following day the fever and rapid pulse persisted, the forearm was very painful, and considerably swollen. The skin chips and a part of the dermal sutures were removed with the escape of a small amount of thin fluid. Culture of the fluid showed a mixed growth of staphylococcus albus and a short chain streptococcus. After removal of the sutures massive warm dressings were applied to the entire upper extremity.

During the five days following the patient was seriously ill with high fever vomiting and obvious toxemia. Her temperature ranged from 99.4 to 104.4 degrees, her pulse from 112 to 144. On the seventh day after operation the symptoms of acute infection began to subside and as they did so wound discharge became more profuse and necrosis of the tissues about the wound became apparent. Although by this time all sutures had been removed and the wound lay widely open, extension of the infection necessitating incision and drainage of the upper forearm April 17 of the thenar space April 23, and of the lower part of the arm above the elbow May 4. May 5 because of considerable loss of blood the day before and because of her critical condition she was given a transfusion of 700 cubic centimeters of citrated blood.

From that time on she improved rather rapidly and left the hospital May 24 eight weeks after the injury with the hand and forearm nearly healed.

During the summer of 1926 she received intensive physical therapy with some improvement in mobility of the fingers.

She was readmitted to the hospital July 26, 1927 a year later. At that time there was definite hypoaesthesia throughout the area of median nerve distribution. The thumb was held in flexion at the interphalangeal joint. The other fingers could be completely flexed, but not completely extended (Fig. 41). At operation July 27 it was found that the suture of the median nerve and the flexor pollicis longus had given way and these structures had become firmly adherent to one another and to the surrounding tissues. The deep tendon to the index finger had healed in a lengthened position. The tendon of the thumb and the median nerve were freed and the ends of each united by end to end suture. The deep tendon of the index finger was shortened.

The range of movement of the hand and fingers and the persistence of atrophy of the thenar muscles August 8, 1930 are shown in Figure 41. At that time sensation to light touch and pin prick was present over the entire median nerve area but somewhat diminished.

CASE 4. W. F. Wesley Memorial Hospital, 137871, 139004, 139315. September 9-16, 1926 December 30-23, 1926 February 8-12, 1927 (Fig. 42)

This patient, a clerk of 26 years, fell as he was leaving his place of work at 5 p.m. September 9, 1926 his left arm shot forward as he fell and crashed through a plate glass door. He was taken to Wesley Memorial Hospital immediately and operated upon shortly after admission under gas and ether anesthesia. The record does not state the exact time of operation, but does state that he returned from the operating room to the ward at 7:30 p.m.

At operation it was found that the ulnar nerve and blood vessels, the flexor carpi ulnaris, and the superficial flexor tendons of the four fingers had been divided. The ulnar vessels were ligated, the divided nerve and tendons sutured.

The morning after operation the patient's temperature was 100.4 degrees. It fell to 99 degrees the following day and remained normal after the third day. On September 14 it was noted by Dr. Mason, "Some discharge from the wound. This is due, I think, to the tincture of iodine which was swabbed liberally in the wound at the time of operation. Temperature normal." On September 16 the patient left the hospital. There was "slight drainage from the wound, not purulent." The exact date of healing is not recorded.

December 20 the patient was readmitted to the hospital because the wound had opened spontaneously several weeks after healing had taken place and discharge from the resulting sinus had persisted. On admission there were several apparently superficial discharging sinuses along the operative incision.

A drop or two of yellow pus could be expressed from them. These sinuses were excised under gas and ether anesthesia and three pieces of knotted suture material removed from the depth of the rather superficial wound. The wound was loosely sutured. The patient left the hospital on the third day.

February 8, 1927, he was readmitted to the hospital with a small discharging sinus still present at the site of the former operation. Because he had a rather severe acute upper respiratory infection no operative procedure was carried out at that time and he left the hospital 4 days after admission. The record does not state the exact time of healing but shows that it was complete April 21, 1927, at the time the photographs (Fig. 42) were taken.

CASE 5. H. D. Wesley, Memorial Hospital 130406 (Fig. 5).

This patient, a girl of 8 years, sustained a jagged wound of the dorsum of the left hand from a broken mirror March 12, 1927. She was taken immediately to a doctor who dressed the hand and advised hospital care.

She was admitted to the hospital 2½ hours after the injury and operated upon under ether anesthesia an hour later. The wound lay directly over the middle of the metacarpus, a triangular flap of skin with its apex above and its base just proximal to the metacarpophalangeal joints had been torn downward, the extensor tendons of the index and middle fingers had been completely divided, that of the ring finger partially divided. The wound was cleansed in the operating room with soap and water, ether alcohol and picric acid solution. The tendons were sutured with silk, the wound edges loosely approximated with interrupted sutures and some strands of silk worm gut left in the wound for drainage. The operation, according to the anesthetist's record, required thirty minutes. Warm wet dressings were applied to the hand at the close of the operation and maintained for the next 9 days.

March 14, 48 hours after operation, the patient's temperature had risen to 102 degrees. The following day, March 15, there was considerable swelling of the flap, three sutures were removed from the skin and a small quantity of seropurulent fluid escaped from the wound. On the fourth day, March 16, a Carrel tube was inserted into the wound and instillation of 3 cubic centimeters of Dakin's solution every 3 hours begun. The warm boric dressings were continued as before. March 18, considerable pus was expressed from the wound, the patient's temperature had gradually receded from 102 to 100 degrees. March 20, the instillation of Dakin's solution was discontinued. March 22, the continuous warm wet dressings were discontinued and instead the hand was soaked for 15 to 20 minutes twice daily in warm sterile boric solution.

The infection cleared up very slowly. April 15, a small localized accumulation of pus under the healing flap was incised and continuous warm boric dressings again applied for 2 days. The wound was almost healed when the patient was discharged from

the hospital May 3, 1927, 7½ weeks after admission. In spite of the prolonged suppuration and the prominent scar on the dorsum of the hand the functional result was excellent (Fig. 5).

In the last case the possibility of chemical injury of the tissues about the wound comes into consideration, as mirror glass injuries in other cases in our experience have been followed by persistent suppuration with slow but progressive necrosis of the surrounding tissues. Whether it was a factor in this case is of course purely conjecture.

Of the 146 patients who came to us for secondary treatment an immediate closure of the superficial wound alone had been carried out elsewhere in 42 cases. In 22 of these cases the wound healed by primary union, in 6 cases there was a slight wound discharge for from 2 days to 3 weeks. In 10 cases suppuration developed. In 4 cases there is no record as to the immediate result.

In 54 of the 146 cases immediate nerve and tendon suture had been carried out elsewhere. In 28 of these the wound healed by primary union, in 8 a low grade infection developed, in 14 suppuration and tissue necrosis took place and complete wound healing was delayed for from 3 to 10 weeks from the time of injury.

In 146 of our cases in which secondary operation was performed, i.e., all the cases except the group of 24 operated upon by us shortly after the injury, the operative wound healed by primary union in 119 cases. In 3 cases there is no record as to the result as far as infection is concerned. In 4 cases failure of primary union was due to slow necrosis either of a longitudinal strip of skin along the line of incision or of a small transverse section of skin centering at the site of the original transverse wound. This necrosis we believe resulted from impairment of the blood supply of the skin flaps, either because of scar tissue formation following the original injury, because of trauma during the operation, because of excessively thin skin flaps, or because the skin was sutured under excessive tension.

In 20 cases of secondary operation failure of primary union was due to infection. In 8 of these infection was described as "slight, low grade, superficial infection of center of

wound etc., and cleared up in from 10 to 24 days after operation. In 4 infection was slight but persistent or recurrent for from two and one-half to six months after operation and subsided when some unabsorbed suture material was extruded. In 8 suppuration developed with some necrosis of superficial and deeper tissues, and complete healing was delayed for from four to eight and one-half weeks after operation.

The incidence of postoperative infection has become steadily less. In 63 out of 71 cases operated upon between June 1929 and July 1932 the operative wound healed by primary union. In 3 of the 8 which did not heal by primary union there was slow necrosis of a strip of skin along the line of operative incision without evidence of infection until this necrosis took place. In 3 the infection was slight and cleared up in from ten to eighteen days after operation. In 1 infection was apparently due to organisms of low virulence but a slight discharge persisted for eight weeks after operation. In 1 frank suppuration and sloughing of tissues took place and healing did not take place until eight and one-half weeks after operation. In spite of the fact that we have not yet succeeded in eliminating infection as a postoperative complication we believe that it is avoidable and that it can be eliminated by watchful care at every stage in the operative treatment from the beginning of the preparation of the hand for operation to the time of removal of sutures.

RESULTS OF SUTURE OF DIVIDED NERVES AND TENDONS

A number of factors conspire to make difficult an appraisal of the results obtained in a group of cases such as that under discussion. The ambition of the workman to secure a good result, the desire of the patient to show a satisfactory result, or occasionally his desire to minimize the degree of improvement because of the possibility of securing additional compensation, the location and extent of the original injury, the interval of time elapsing between the injury and the operation, the amount of scar tissue formation present at the time of operation which is usually directly dependent upon the extent and character of

the infection which followed the original injury, the time that has elapsed between the operation and the last examination—an essential consideration in the case of nerve suture and the faithfulness with which physical therapy exercise and use of the injured hand have been carried out. Because of these many factors affecting each case in varying degree it is almost impossible to classify the results obtained as excellent, good, etc. If a patient secures a usable and useful hand after a severe injury and serious infection that have resulted in complete loss of function for a year or more such a result can fairly be considered excellent, though the hand may be far from perfect as compared with the normal. On the other hand if one secures a result somewhat less than perfect in a case in which every condition has been favorable, it can not truly be considered an excellent result. The results of nerve suture particularly are difficult to interpret.¹⁵ The rapidity with which overlap from adjacent nerves develops in the area supplied by the divided nerve varies in different individuals and as has been stated above this one factor emphasized particularly by Pollock, is a constant possible source of error in interpreting the findings present after nerve suture. The patient's interpretation of the signs of returning sensation is often misleading and one must be conservative about drawing conclusions simply from a patient's statement (Fig. 14).

We have not been able to secure results such as Bunnell has obtained—return of sensation at the rate of a phalanx a month after suture of the digital nerves—nor have we seen return of function appear as rapidly in the majority of cases as is suggested by most writers to be the normal expectancy. On the other hand we have seen progressive improvement taking place for a long period after operation and continuing far beyond the time ordinarily considered as marking the limit of possible improvement. We say ordinarily considered, although we do not know of any accurate statements concerning the length of time during which improvement can be expected to continue after nerve suture. In this

¹⁵ "The prognosis of nerve suture is a matter of great complexity and the term 'recovery' as an adjective is almost to come to nerve tissue long. Baetjer and Twining."

connection the following case report is of particular interest, and especially so because the patient is a physician and accustomed to making accurate observations

R. A., Wesley Memorial Hospital 50951 (Fig. 43)

This patient, a 23 year old medical student at the age of 1, plunged his right hand through a glass window and divided the median nerve and long flexor tendons of thumb index and middle fingers. The tendons were sutured soon afterward the wound healed without infection. After the accident complete anesthesia in the median nerve area persisted the skin became somewhat atrophic and gross changes in appearance and brittleness appeared in the nails of thumb index and middle fingers. Atrophy of the thenar muscles was slow but progressive. There was impairment of flexion of the thumb and complete loss of flexion of the index finger

December 19, 1914 6 years after the accident nerve and tendon suture were performed by Dr. Kanavel. At operation it was found that the proximal segment of the median nerve had become united to the distal segment of the flexor pollicis longus. Nerve and tendon were separated and an anatomical restoration carried out. The patient was discharged from the hospital 5 days after operation postoperative recovery was complicated by persistent serous drainage from a small sinus complete healing took place after a piece of unabsorbed cat gut was removed from the wound.

January 8, 1932, the patient stated. Sensory change following the operation was very slow in appearing. There was very little change at all during the first year but progress in both sensation and cutaneous trophic changes was progressive after three years. In fact I believe that there was as much change after three years as there was before.

"The hand gradually improved year by year and apparently has improved not only in appearance but in sensation even in the last few years.

As you know from the last examination there is now very little difference in the palmar surface of the two hands and the only sign of trophic disturbance is that the skin along the ulnar side of the thumb nail is rough and indurated. Otherwise the nails appear practically normal. There are still a slight perceptible roughness and lack of markings in the radial one-half of the palm. The thenar atrophy has never improved. All function is present in the hand and I am able to flex the fingers completely with the fingers in full extension at the metacarpophalangeal joints. I operate with this hand, use the scalpel, and have normal use in the fingers (Fig. 43) except that I do miss the opponens action.

Another fact should be recorded which concerns particularly the results of tendon suture but which applies to patients with nerve suture as well. Division of tendons and nerves is

followed by retraction and atrophy of the divided tendons and muscles and atrophy of the muscles innervated by the divided nerves. Its extent depends to a considerable degree on the interval elapsing between the injury and the reparative operation. When the divided tendons are united movement is again made possible but such movement at first is often sluggish and definitely limited. With use however even though it is minimal at the outset the atrophic process is arrested and the cycle is reversed. Use of the part stimulates blood supply and muscle and nerve regeneration. Muscle and nerve regeneration and return of motor nerve function permit a little greater use and movements of greater range and power. In other words the reversed cycle becomes a beneficent one instead of a vicious one and each phase re-enforces the other. The result is that patients who have gained only a limited restoration of function at the end of a few months often return after a year or eighteen months with a surprising and sometimes unexpected degree of improvement.

We believe we can say fairly that the results of operation have justified the efforts the time and money which the patients have expended in the attempt to secure improved function and secondly that our results have definitely improved with increasing experience and increasing efforts to secure healing by primary union and without infection. A few patients have secured a perfect functional result and it is such cases particularly that encourage us to keep on trying to perfect our technique to such a point that we can in fairness hold out to every patient with division of nerves and tendons the reasonable assurance of a satisfactory result.

SUMMARY

In the treatment of divided nerves and tendons a careful examination of the patient before operation to determine the degree and extent of injury is of primary importance. To choose the wisest plan of immediate treatment requires careful consideration of a number of factors, unless one can be reasonably certain that the wound is free from infection it is far better to leave the superficial wound

open or suture it loosely and permit it to heal than to run the risk of opening tissue spaces widely and bringing about widespread extension of a virulent infection.

When operation is performed whether immediately or at a later date, every effort should be made to ensure healing by primary union for in securing a successful result nothing in the way of accurate apposition, careful suture or painstaking postoperative care can compensate for failure to secure wound healing without infection.

In the technique of operation gentleness in the handling of tissues, accurate apposition of tendons, end-to-end apposition of healthy nerve ends, the use of fine suture material and the employment of a bloodless field during the operative procedure are important details. Properly designed splints and skilfully applied physical therapy are important and helpful adjuncts in securing successful results in the shortest possible period of time after operation.

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OBSERVATIONS ON THE MECHANISM AND SIGNS OF SEPARATION OF THE PLACENTA

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SINCE 1914 the author has been practicing as a matter of routine a method of facilitating separation and delivery of the placenta, which has met all indications, although, since it involves considerable inconvenience in maintaining asepsis it is now employed only in cases in which there is lack of contraction of the uterus, bleeding or adherent or retained placenta. This method (2) was original with him and was named by him the dorsosquatting posture suggested by the posture assumed at stool by primitive peoples (3). It is an evolution of the one called exaggerated lithotomy position which DeLee advocated in cases of inefficient pains and in moderately contracted pelvis, at the end of the first and the beginning of the second stages of labor (1). Figure 1 shows the dorsosquatting posture with pelvis suspended. Figure 2 the dorsosquatting posture in action during the third stage of labor. In this all the pelvic diameters are increased the rectus muscles contract and harden intra-abdominal space is diminished and intra-abdominal pressure is increased. Uniform continuous pressure on the uterus causes correspondingly regular contraction and retraction. The sinuses empty the blood vessels regain their tonicity to some extent and the uterus thus contracts retracts and remains firm. This is accomplished in 6 or 7 minutes but the posture is maintained for a few minutes longer at which time the placenta is easily expelled intact and with comparatively little free loss of blood. The posture is continued for another short period to insure the contraction and involution of the uterus.

SIGNS OF SEPARATION OF THE PLACENTA

Thus far the only reliable sign indicative of separation of the placenta is a firmly contracting uterus, all other so called signs being only theoretically incidentally or occasionally true. Dr Morris Leff from observations on a

thousand cases, finds that the placenta separates completely soon after the uterus is reduced in size and that separation occurs from 2 to 5 minutes after tying the cord or a maximum of 8 or 9 minutes after delivery of the fetus. He comes to this conclusion after digital examination of the vagina when he finds the placenta at the level of or somewhat lower than, the external os.

The author considers the placenta separated only when it is lying freely in the vagina. Otherwise, it is only partly separated, being still sustained by part of the placenta or the undetached membranes and these membranes are almost as likely as the placenta proper to give trouble both during and after delivery. Even in the Schultz method when the bulk of the placenta can be felt at the lower edge of the cervix or upper end of the vagina it may still be upheld by undetached membranes or by all or part of its normally most adherent position—the circular edge. Even the size of the placenta thus palpable is but relative since at this time all the diameters of the uterus are diminished and the passive lower segment, drawn up to the higher level, exposes to palpation a larger area of placenta regardless of the extent of separation, a condition more marked in low implantation of the placenta. This area may be still further increased by the resiliency inherent in the placenta, which causes it to accommodate itself to a contracting uterus without separation but with the formation of a convex bulge.

Recent observations show that in normal cases the placenta presents itself at the level below the dilated external os usually after the third fourth or fifth regular contraction exclusive of the initial contraction following delivery. Occasionally the placenta will separate after the first contraction if this is strong and prolonged. It descends and becomes tense with each contraction and rises and

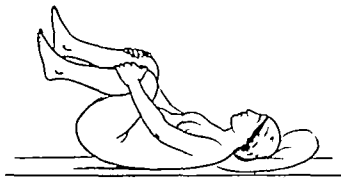


Fig. 1

softens during relaxation. If the contractions are more pronounced than the relaxations the placenta will progressively descend without rising and softening during the intervals. Normally the internal os or contraction ring forms immediately after expulsion of the placenta to the extent of diminishing the lumen of the lower segment of the uterus to a diameter varying from one half to one and a quarter inches with the soft, thin and relatively shrunken cervix below and in front of it. Soft and ill-defined ring formation before the descent of the placenta is not infrequent, but if expression is not forced or hurried it will yield sufficiently to allow its passage and then immediately recontract. Two cases were observed in which the cervix consisting at this time normally of a loose soft circular flap before the placenta presented itself at the external os, assumed the form of a number of firm, irregular concentric convexities in horizontal position making up the cervical canal. With the expulsion of the placenta the cervix was immediately drawn up with the convexities in perpendicular concentric position facing the uterine canal, the vaginal surface thus assuming the aspect of normal cervical mucosa and the external os admitting one finger. Since in neither case could the examining finger feel the usual contraction ring with the soft cervix below and in front of it, the occurrence might be explained on the basis of atypical ring or external os formation.

IRREGULARITIES AT THE PLACENTAL SITE AND POSSIBLE MECHANISM OF ITS OCCUR- RENCE

In January 1920, while waiting for signs of separation of the placenta the author noticed

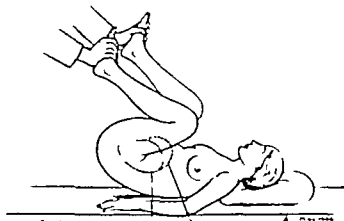


Fig. 2.

an irregular area on the uterine wall located sometimes on the fundus sometimes on the anterior and sometimes on the posterior wall having the appearance of multiple shallow subserous fibroids. Further observations showed that in the vast majority of cases except in those in which there was complete hardening of the uterus this sign made its appearance from 10 to 15 minutes after the birth of the fetus which is a little less than the average time it takes for the placenta to separate. While the presence of this sign may not always be an evidence of complete separation of the placenta, it does imply a maximum amount of detachment and more important still a higher degree of contraction and retraction making it safe at this time to attempt expulsion. No difficulties were ever encountered when attempts at expression were made after the appearance of this sign. In the majority of over two hundred cases in which the separation of the placenta was studied by means of palpation with fingers in vagina to a height above the external os the irregularities appeared after the placenta was lying freely in the vault of the vagina. These irregularities can form only at the placental site, which at this time is the most vascular and therefore the most yielding part of the uterus. The following attempt has been made to explain the mechanism of their occurrence.

The pregnant uterus may be compared to a syringe with yielding or collapsible wall, minus an opening for the nozzle and with a piston of two parts the fetus and the placenta. With the gradual dilatation of the cervix, beginning at the establishment of the first stage

of labor the vacuum principle initiated by the contractions and relaxations of pregnancy is set into play. The tendency of the uterus to contract obliterates the vacuum caused by relaxation and forces the fetus downward. The following relaxation creates a new vacuum forcing the fetus upward but to a less degree than the preceding one and the succeeding contraction in its turn continues the downward course of the fetus. When the uterus is sufficiently drawn up above the presenting part to cause this vacuum to become inefficient the abdominal muscles and intra-abdominal pressure readily supplement this deficiency. With the expulsion of the fetus the major part of the piston disappears and the uterus contracts obliterating the vacuum space. The placenta and membranes now become puckered or partly separated with resultant vacuum formation and with the aid of inherent contraction retraction and relaxation and retroplacental blood formation these vacua cause after the placenta is sufficiently separated and the sinuses obliterated by means of compression and aspiration an irregular caving in of the placental site.

The following observation in a general way proves the reality of the syringe vacuum principle which is operative during pregnancy and labor.

Mrs. A. E. 1-para, full term measurements and pregnancy normal delivered of twins on March 14, 1930 at Hunt's Point Hospital. First infant occipitoposterior was delivered with forceps. The second, larger infant presented too high for forceps application. With patient still anesthetized podalic version was performed. When legs presented at vaginal outlet, patient's respiration became loudly stertorous and deep and with each respiration the fetus progressively descended until it reached the nipple line when patient's respiration became more normal, and spontaneous progress ceased.

In 2 later cases of breech extraction delivered in private homes the phenomenon was absent in the first, which was a very large

child and present in the second, which was a 6 pound child. There is reason therefore to believe that in the absence of relative disproportion between the parturient outlet and the child this mechanism or its tendency should be manifest.

The same tendency is felt though in reversed order when attempts are made in primiparae to stretch the vagina with the fist previous to operative interference. As soon as the fist passes the hymenal sphincter the upward suction with each respiration can be distinctly felt.

It has further been observed in a number of forceps deliveries at the time the vaginal sphincter engaged the largest diameter of the head, if the forceps were then used simply as a means to prevent its recession the respirations became deep and stertorous and with each respiration progress was made until the sphincter grasp was relieved.

Another illustration of the vacuum principle, which casts light on the mechanism involved in the maintenance of fetal heart action and circulation is supplied by the cutting away of a portion of the cord just below the ligature applied before it is severed and the squeezing out of the blood, starting at the placental end. The cord will immediately refill with the placental blood. This may be repeated for as long a period as 30 minutes and the cord will promptly refill, regardless of the position in which it is held.

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POSTOPERATIVE PULMONARY COMPLICATIONS

I. A STATISTICAL STUDY BASED ON TWO YEARS' PERSONAL OBSERVATION¹

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THIS study of postoperative pulmonary complications occurring on the General Surgical Services of the Massachusetts General Hospital was begun in the fall of 1929. It was made from the standpoint of the internist and was undertaken at the suggestion of Dr. L. S. McKim of the Surgical Service. After a preliminary study of the hospital records, it was found that figures from these records were unsatisfactory, since the milder pulmonary complications as a rule were not included in the discharge diagnoses and adequate descriptions of the complications were not recorded. For example, only 44 per cent of the complications occurring in 1929 were listed in the discharge diagnoses. (The remainder were found by a study of the bi-monthly surgical reports or the hospital records and by personal observation.) It was apparent, therefore, that really satisfactory statistics could be obtained only by personal observation during the period for which figures were to be reported. Accordingly, the author observed personally practically all of the postoperative pulmonary complications in 1930 and 1931, and in addition studied a great many cases of the type in which complications most frequently develop although they did not actually occur. The observations have been made carefully, and the figures have been compiled accurately, so that although most of the conclusions are not new, they are based upon a series of cases sufficiently large to make the percentages reliable and they emphasize points which we believe essential to an understanding of the problem.

The nature of the process. The study has been confined to the type of complication which occurs in the first three or four days after operation and is almost always accompanied by fever, leucocytosis, cough, and purulent sputum. Cases of proved pulmonary embolus, exacerbation of pulmonary tuberculosis, empyema, and so forth, have been excluded. The type of complication studied has

been diagnosed in the literature as bronchopneumonia "pneumonitis" or collapse (atelectasis). In the series here reported a certain number of cases have run the clinical course and presented the physical and X-ray signs of a true bronchopneumonia. The percentage of these cases is small; nevertheless the group is important since it includes most of the fatal cases. There is also a much smaller number of cases which can be diagnosed clinically and by X-ray as typical "massive collapse" produced by occlusion of a large bronchus by exudate and clearing quickly when the "plug" is expelled by cough. Between these two definite entities lies a large "intermediate" group of cases which are more difficult to classify.

The lesion in this intermediate group is not "pneumonia" in the medical sense since it runs a much shorter and less toxic course. Whipple (6) has called it "pneumonitis" using that term to mean a "pneumonia" in which the alveolar exudate is caused by a relatively avirulent pneumococcus, is lacking in fibrin and is therefore quickly absorbed. Cutler has regarded it as embolic pneumonia but the onset is much earlier than in most proved cases of pulmonary embolus and the symptoms and signs are so different that his theory is difficult to prove. Coryllos has championed the collapse theory, maintaining that the steps in the development of postoperative "pneumonia" are bronchitis, obstruction of a bronchus by exudate, atelectasis due to bronchial obstruction and then pneumonia developing in the collapsed area.

The differential diagnosis is, then, between low grade bronchopneumonia (better termed "pneumonitis") and lobar or lobular atelectasis. A study of X-rays and physical signs has assisted in the attempt at differentiation.

Dr. G. W. Holmes of our X-ray Department, is of the opinion that those cases in which the X-ray shows increased density with a definite diminution in lung volume on the affected side should be diagnosed as collapse

¹ A study made on the Surgical Services of the Massachusetts General Hospital by the author, a member of the Medical Service.

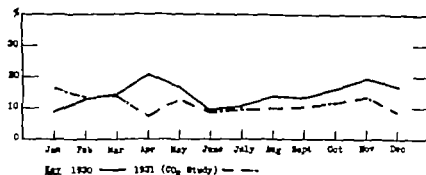


Fig. Monthly percentage of pulmonary complications following laparotomies and hernia operations in 1930 and 1931 (CO₂ study)

This reduction in volume is shown in the typical case by displacement of the mediastinum, elevation of the diaphragm downward inclination of the ribs and narrowing of the intercostal spaces. All of these signs of collapse are not present in every case. Displaced mediastinum or elevated diaphragm may occur alone. Dr. Holmes calls attention to the danger of making a diagnosis from an X-ray film taken at full inspiration because, at this phase of respiration displacement toward the affected side is present in consolidation as well as in atelectasis. In a true atelectasis displacement toward the side of the lesion is present on expiration as well as on inspiration while in consolidation this displacement is present on inspiration only. Care must be taken also to exclude those films in which X-ray signs might be due to exposure at complete expiration (5). Further it must be remembered that in a bilateral process of any sort there is usually no displacement of the mediastinum.

TABLE I.—CLASSIFICATION

	1928	1929	1930	1931
Collapse	16	25	87	113
"Bronchopneumonia	73	16	152	74
Total	89	41	239	187
Bronchitis	—	142	92	11

The classification of cases in Table I is based largely on X-ray evidence of diminished lung volume. It is interesting to note that as the years have gone on and knowledge of the process has increased, the diagnosis of atelectasis has become more frequent, so that whereas in 1928 less than one fifth of the total complications were diagnosed as collapse in 1931 two-

thirds of the cases were so recorded. Of the 200 cases classified as collapse in the years 1930 and 1931 78 could be diagnosed on the basis of physical signs alone and the other 122 required X-ray evidence of diminished lung volume. (To complete the figures, the number of cases of bronchitis without parenchymal involvement has been added to Table I.)

The study of physical signs has become increasingly important because of the stress which has been laid upon bronchial obstruction as a factor in the production of postoperative pulmonary collapse. Dr. Frederick T. Lord of this hospital, has made a study of the physical signs which occur with bronchial obstruction and has repeatedly shown that obstruction of a bronchus from any cause gives dullness and absent or much diminished breathing (without bronchial breathing) and absent or diminished voice (without egophony) and diminished whisper and tactile fremitus. If however the bronchial obstruction is removed and the atelectasis persists, the signs change and are those of consolidation. It is especially important to call attention to the signs of atelectasis with open bronchus because many authors have assumed that when bronchial breathing appears over a collapsed area, a true pneumonia has unquestionably developed.

If one is to accept the theory that most postoperative pulmonary complications are atelectases due to occluded bronchi the first signs should be very much diminished or absent breathing which, when the bronchus is open, should change to bronchial breathing and the other signs of consolidation (unless the lung expands immediately). In some cases

(16 of our 1931 series), this progression of signs did take place and it is possible that very frequent examinations started soon after the operation would show it in most cases. Actually in 1931 140 of 187 pulmonary complications showed definite changes in breath sounds. Of these diminished breathing was the first change noted in 66 cases and bronchial breathing was the first change in 74 cases. These groups ran practically the same clinical course and it was impossible to say that diminished breathing at the first examination indicated collapse while bronchial breathing at this time indicated pneumonia. Forty five of the 66 cases with diminished breathing at first examination and 44 of the 74 cases with bronchial breathing were eventually diagnosed as collapse. Physical examination therefore except when it shows definite mediastinal displacement is of little value in separating pneumonia from collapse. The important point to remember is that bronchial breathing may indicate either pneumonic consolidation or an atelectatic area with open bronchus. (In interpreting physical signs, it should be borne in mind that an elevation of one side of the diaphragm which frequently follows abdominal operation will often account for diminished breathing at the base without the presence of atelectasis.)

Table I shows the large number of cases of bronchitis in which the X ray has shown no parenchymal involvement. Many of these cases ran the same clinical course as those in which portions of the lung were involved. We believe, therefore, that a purulent bronchitis develops in a large percentage of postoperative cases, that in some cases the infection is limited to the bronchi, and that in the intermediate group of pulmonary complications, now under discussion there is an accompanying "pneumonitis," combined at times with atelectasis due to occlusion of the bronchi by exudate. We have found no evidence that atelectasis necessarily precedes pneumonitis and have been able to prove atelectasis in only 47 per cent of our series of cases. In most instances a sharp distinction cannot be drawn between pneumonitis and collapse in this intermediate group, the underlying lesion in all cases being purulent bronchitis. (An occa-

sional instance has been observed with "simple collapse," having very little fever and no expectoration.)

As noted in the beginning there is a small group of typical bronchopneumonias which can be clearly differentiated from the intermediate group just described. In 1930 and 1931, there were 30 cases of this type. Eleven of the 13 fatal cases were included in this group and showed from the start a diffuse bronchopneumonic process in the upper as well as the lower lobes and there was no evidence that there had been a preceding atelectasis. In the 2 other fatal cases pneumonia may have developed in an atelectatic area.

Since this is primarily a statistical study the theories of etiology will not be further discussed nor will the considerable literature on the subject be reviewed both having been frequently and exhaustively presented by other authors.

TABLE II MORBIDITY AND MORTALITY

	Percentages		
	1929	1930	1931
Pneumonia and collapse			
In all operations	3.7	6.8	5.2
Laparotomies and hemiorrhaphies only	7.7	14.3	11.3
Mortality due primarily to pneumonia and collapse			
In all operations	0.3	0.6	0.4
Laparotomies and hemiorrhaphies only	0.9	1.1	0.8
Mortality all causes	9.9	8.7	8.6
In "pneumonia" and collapse	33.3	24.3	20.3

Percentage of complications. Table II gives a summary of the percentage of complications with the accompanying mortality incidence occurring on the General Surgical Services¹ in the 3 years 1929, 1930, and 1931. Although the author's routine personal observation of patients did not begin until 1930, a very careful study of every surgical record, in 1929, gives statistics that are of interest for comparison. The figure for incidence of postoperative pulmonary complications following general and abdominal operations is higher than that reported by other authors (1, 3, 6).

Mortality. In the group in which death was "due primarily to pneumonia and collapse" are included those patients whose postopera-

¹In the Massachusetts General Hospital there are special services for genito-urinary, orthopedic, eye, ear, nose, and throat surgery.

TABLE III.—MORTALITY

Complication considered as	Number of patients	
	1930	91
Primary cause of death	5	8
Major contributing cause of death	10	8
Minor contributing cause of death	25	14
No connection with death	12	8
Total	52	38

tive pulmonary complication was either a primary or a major contributing cause of death. It will be noted that although a rather large percentage of patients developing pulmonary complications do not live, the percentage of those in whom the complication can be considered as a definite factor in the patient's death is comparatively small. The fact is again emphasized in Table III which analyzes further the group who have had pulmonary complications and have died.

Severity Table IV presents the cases grouped according to severity. The cases presenting clinical symptoms and signs of bronchitis, but in which the X-ray demonstrated definite parenchymal involvement, have been classified as mild.

Sex and type of operation The most important factors in the occurrence of postoperative pulmonary complications are type of operation and sex of the patient. The figures for the various types of operation in the two sexes are given in Tables V and VI. These figures bring out the following facts. The incidence of pulmonary complications among men is at least

TABLE IV.—SEVERITY

	Number of patients	
	1930	91
Severe	33	17
Moderate	140	122
Mild	64	43
Total	237	182

twice that among women. Complications are more than twelve times as frequent following laparotomy and herniorrhaphy as after operations in the non-abdominal group. They occur most frequently following operations on the stomach and duodenum, gall bladder and intestines. Therefore the group of men having operations on the stomach and duodenum, gall bladder and intestines has been designated as the "bad risk" group because of their consistently high percentage of pulmonary complications. In the group of non-abdominal operations complications have occurred most frequently after operations on the thyroid. Of 134 patients having thyroid operations in 1930, 10 developed pulmonary complications which gives a percentage of 7.5 and in 1931, 7 of 102 patients or 6.9 per cent, developed complications. It will be noted that of the fourteen complications following non-abdominal operations in 1931, half occurred after operations on the thyroid.

Septis and perforation Table VII gives a further analysis of the cases grouped in Tables V and VI under stomach and duodenum and appendix. The extraordinarily high

TABLE V.—TYPE OF OPERATION AND SEX—1930

Operation on	Total			Male			Female		
	Operations	Complications	Per cent complications	Operations	Complications	Per cent complications	Operations	Complications	Per cent complications
Stomach and duodenum	97	38	39.2	83	37	44.5	14	1	7.1
Intestines	54	30	55.6	73	33	45.2	40	7	17.5
Gall bladder	52	32	61.5	43	7	16.3	9	25	27.8
Appendix	473	51	10.8	314	38	12.1	159	13	8.2
Non-abdominal laparotomy	70	3	4.3	60	9	15.0	10	4	40.0
Gynecological laparotomy	253	12	4.7	—	—	—	253	12	4.7
Hernia	240	20	8.3	3	3	100.0	237	17	7.2
Total abdominal and hernia	300	5	1.7	739	145	19.6	107	19	17.8
All others	953	84	8.8	620	100	16.1	91	5	5.5
Total	2450	119	4.8	2460	245	9.9	700	28	4.0

TABLE VI—TYPE OF OPERATION AND SEX—1931

Operation on	Total			Male			Female		
	Opera-tions	Complica-tions	Per cent compli-cations	Opera-tions	Complica-tions	Per cent compli-cations	Opera-tions	Complica-tions	Per cent compli-cations
Stomach and duodenum	9*	41	4.5	73	37	5.1	74	4	5.4
Intestines	12	21	17.5	74	16	21.6	47	5	10.6
Gall bladder	172	4	2.3	39	9	23.1	142	13	9.2
Appendix	454	44	9.7	227	25	11.0	227	9	3.9
Miscellaneous laparotomy	113	7	6.2	74	6	8.1	39	1	2.6
Gynaecological laparotomy	112	23	20.5	—	—	—	112	23	20.5
Hernia	13	13	100	12	11	91.7	1	—	—
Total abdominal and hernias	13	121	923	652	115	17.6	810	17	2.1
All others	2055	14	0.7	5	7	140	201	7	3.5
Total	3195	137	4.3	1544	121	7.8	1751	64	3.7

TABLE VII—COMPARATIVE STATISTICS IN RELATION TO SEPSIS

Operation	1930						1931					
	Male			Female			Male			Female		
	Opera-tions	Complica-tions	Per cent compli-cations	Opera-tions	Complica-tions	Per cent compli-cations	Opera-tions	Complica-tions	Per cent compli-cations	Opera-tions	Complica-tions	Per cent compli-cations
Gastrostomy	15	8	53.3	4	—	—	11	2	18.2	9	2	22.2
Gastro-enterostomy	25	8	32.0	9	2	22.2	20	11	55.0	5	1	20.0
Gastric resection	10	7	70.0	8	1	12.5	17	10	58.8	4	1	25.0
Gastric and duodenal suture	10	11	110.0	—	—	—	15	9	60.0	1	—	—
Cholecystgastrostomy	7	2	28.6	—	—	—	1	1	100.0	1	—	—
Intestinal, palliative	57	11	19.3	15	6	40.0	47	21	44.7	15	3	20.0
Intestinal resection	18	8	44.4	13	3	23.1	3	2	66.7	1	2	200.0
Intestinal anastomosis	1	—	—	—	—	—	2	1	50.0	1	—	—
Intestinal suture	2	2	100.0	—	—	—	2	1	50.0	1	—	—
Appendectomy alone	127	9	7.1	101	6	5.9	131	13	9.9	114	3	2.6
Appendectomy with exploration	43	8	18.6	87	5	5.7	45	5	11.1	97	2	2.1
Appendectomy with drainage	65	0	0.0	31	5	16.1	6	13	216.7	24	2	8.3
Isolating and drainage appendix alone	6	—	—	7	2	28.6	11	—	—	4	1	25.0

percentage of pulmonary complications in men following gastric and duodenal suture is of especial interest, as well as the high percentage of complications occurring in 1930 after gastrostomy alone. That complications do not occur simply as a result of opening the abdomen, but are dependent to a great extent upon the pre-operative condition of the individual patient is well brought out by the analysis of the appendectomy group. The figures show a much higher percentage of pulmonary

complications following appendectomy with drainage than after simple appendectomy or appendectomy with exploration.

Pre-operative respiratory infection. The tables so far mentioned stress the importance of the type of operation and the presence of pre-operative sepsis. In addition the relation of pre-existing respiratory infection to the development of postoperative pulmonary complications has been of interest. Of the 239 complications occurring in 1930, only 26 (10.8

TABLE VIII.—LAPAROTOMIES AND HERNIA OPERATIONS—MONTHLY INCIDENCE

	Per cent postoperative pneumonia and collapse	
	1930	1931
January	7.9	16.4
February	9.7	13.6
March	14.4	14.3
April	21.1	7
May	16.7	3.8
June	9.7	0.3
July	10.8	0
August	13.7	0.0
September	3.3	10.5
October	10.4	11.8
November	19.8	3.4
December	7.0	8.7
Percentage for year	14.3	3

per cent) had pre-operative respiratory infection of an acute or chronic nature. Of the 187 cases in 1931 35 patients (18.7 per cent) had such pre-operative infection. The apparent increase in the 1931 figures is undoubtedly due to the careful recording of pre-operative infections by the nurse in charge of carbon dioxide inhalations.

There are no figures available to show the relation of acute respiratory infection in the community at large to the occurrence of post-operative pulmonary complications in the hospital except those for lobar pneumonia which show that the pneumonia curve is not paralleled by our curve for pulmonary complications.

Monthly incidence. Table VIII and Figure 1 give the percentage of postoperative pulmonary complications by months for the 2 years, 1930 and 1931. Since the incidence of pulmonary complications is so much higher after laparotomy and herniorrhaphy the monthly incidence is computed for this type rather than for the total number of operations. In 1930 there was a definitely higher percentage of complications in the late spring and late fall than during the summer but there is not the marked seasonal variation which has been reported by some authors. In 1931 the highest percentage occurs in January February and March, with slight elevation again in October and November. Improved methods of bronchial drainage are probably responsible for the lower percentages in the latter part of 1931.

The severity of the complication in relation

to season has been studied and here the figures for the 2 years differ markedly. The severe complications in 1930 occurred predominantly in October November December and March—in the winter months. In 1931 almost half of the severe complications occurred in the 4 months, May to August inclusive—predominantly in the summer months.

Anesthesia. Table IX shows the percentage of pulmonary complications occurring after laparotomies and herniorrhaphies under the different types of anesthesia. The figures for 1931 do not include the total operations for the year since they are compiled from a group of cases selected for a special study (4). However they do cover a great majority of the operations performed and are a representative group for the year. (The patients given spinal or rectal anesthesia with supplementary ether are included in the 'inhalation' group.)

The high percentage of complications occurring in the group which were given spinal anesthesia is of interest and many surgeons have been of the opinion that this high percentage was due to the fact that the poorer operative risks were selected for spinal anesthesia. Consequently an attempt was made to analyze a type of operation in which the pre-operative condition of the patients in the group given ether was as nearly as possible the same as the pre-operative condition of the patients in the group given spinal anesthesia. The male patients with hernias, between the ages of 30 and 60 years operated upon in 1930 were selected as more nearly approximating these requirements than any other group. Table X gives the results and shows a higher percentage of complications after spinal anesthesia in every age group. It is true, however that a further study of the group revealed that of the 66 cases selected for inhalation anesthesia, all were considered good ether risks except 8 who were designated as fair. (Two of these patients had strangulated hernias.) Of the 54 patients selected for spinal anesthesia 19 were listed as fair ether risks and 3 as 'poor' risks. (Four patients were operated on for strangulated hernias.) It would seem from this that the increased percentage of complications after spinal anesthesia is due

TABLE IX.—ANÆSTHESIA

	Incidence in laparotomies and hernia operations					
	1930			1931—CO ₂ study		
	Operations	Complications	Per cent complications	Operations	Complications	Per cent complications
Inhalation	1108	151	13.5	1112	13	11.7
Spinal	27	41	15.2	101	13	12.8
Avertin	—	—	—	35	3	8.6
Local	70	15	21.4	73	13	17.8

TABLE X.—MALE PATIENTS WITH HERNIAS—1930

Age	Anæsthesia					
	Inhalation			Spinal		
	Operations	Complications	Per cent complications	Operations	Complications	Per cent complications
20 to 29 years	21	2	9.5	4	1	25.0
30 to 39 years	1	2	200.0	7	—	0.0
40 to 49 years	2	2	100.0	17	4	23.5
50 to 59 years	10	1	10.0	4	4	100.0
Total	34	7	20.6	32	9	28.1

in part to a poorer pre-operative condition of the patient

It is of especial interest to note that in both years the percentage of complications was highest after local anæsthesia. Most of the operations in this group were palliative intestinal operations done for relief of intestinal obstruction due to malignancy. This lends further support to the opinion that the pre-operative condition of the patient is a more definite factor in the development of pulmonary complications than length of operation or type of anæsthesia.

The group of patients given avertin in 1931 is a small series of carefully selected 'good risks'.

Bacteriology In the winter of 1930 a pneumococcus typing was done on the sputa of 44 patients. Of this number the specimens from 14 patients contained very few pneumococci and of the 30 sputa which gave a good growth of pneumococci in the mouse 10 were Type III and the remainder Type IV. At the present time a more complete study of the bacteriology of postoperative pulmonary complications is being made at the Massachusetts General Hospital.

SUMMARY

Statistics based upon 2 years personal observation of the postoperative pulmonary complications occurring on the General Surgical Services of the Massachusetts General Hospital have been presented. Figures have been tabulated separately for the 2 years showing strikingly similar percentages in most instances.

A brief summary combining the figures for the 2 years brings out the following points:

1. Purulent bronchitis develops in a large percentage of patients after operation. In the type of pulmonary complication discussed, bronchitis is associated with 'pneumonitis'. In 47 per cent of the cases there has been sufficient bronchial obstruction to give rise to atelectasis.

2. Eleven of the 13 fatal cases were true bronchopneumonias without evidence of preceding atelectasis.

3. Pneumonia "pneumonitis" or collapse has developed in 6.0 per cent of all operations and in 14.0 per cent of laparotomies and herniorrhaphies and in 7.2 per cent of thyroid operations.

4 The pulmonary complication is regarded as primarily responsible for or as a major contributing cause of death in 0.5 per cent of the total operations performed and in 1.2 per cent of the laparotomies and hernia operations.

5 In practically any given type of operation, the percentage of complications is at least twice as high for men as for women.

6 Among males, the incidence of complications following operations on the stomach and duodenum is 46.8 per cent, on the gall bladder 35.6 per cent, and on the intestines, 26.2 per cent. This group is designated as the 'bad risk' group.

7 Following gastrostomies and palliative operations for intestinal obstruction 22.2 per cent of the patients developed pulmonary complications, and among the patients having gastric and duodenal suture the incidence was 61.8 per cent.

8 After drained appendices 22.5 per cent complications occurred, as compared with 6.6 per cent following simple appendectomy.

9 Of the 426 complications, only 14.3 per cent had pre-operative, acute, or chronic respiratory infection.

10 The seasonal curve does not parallel that for lobar pneumonia or show any consistent seasonal rise.

11 The somewhat lower percentage in 1931 is probably due to better bronchial drainage.

12 In laparotomies and herniorrhaphies 12.7 per cent of the patients operated upon under inhalation anesthesia developed pulmonary complications, 16.6 per cent of those under spinal anesthesia, and 18.4 per cent of those under local anesthesia.

CONCLUSIONS

1 Purulent bronchitis and 'pneumonitis' are present in practically all instances of the type of pulmonary complication here described. Atelectasis is associated with the infection in about one half the cases, but severe and fatal cases are usually true bronchopneumonias without evidence of atelectasis at any stage.

2 Complications occur especially in males following operations on the stomach and duodenum, gall bladder and intestines.

3 Pre-operative sepsis and perforation, as well as malignancy and poor general condition are important factors.

4 Season and pre-operative respiratory infection play a minor part.

5 From the statistical standpoint the type of anesthesia is without significance.

We wish to express our grateful appreciation to the entire Surgical Service and the X-ray Department for their interest and ever ready co-operation.

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TWO RAPID TESTS FOR PREGNANCY

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SINCE it has been shown that the rhythmic vascular changes in endometrial transplants onto the iris are arrested by follicular hormone (Markee 1929) the possibility of using that modification of the uterine vascular rhythm as a test for the presence of follicular hormone in the urine of pregnant women suggested itself. Two tests for pregnancy have been devised and their advantages and inherent difficulties investigated. The tests were made in two ways: directly by the injection of follicular hormone that had been extracted from the urine, and indirectly by the intravenous injection of untreated urine from pregnant women. The urine of 147 pregnant and 26 non pregnant women has been tested.

METHOD OF RECORDING THE RHYTHMIC
UTERINE VASCULAR CHANGES

It was found that endometrial transplants in the anterior chamber of the eye rhythmically bluish and blanch (Markee 1929). Kymographic records of these color changes were made in the following way: Six lines equal distances apart were drawn around the drum of a kymograph to represent the colors of 0 to 20, 30, 40, and 50 per cent of haemoglobin respectively. The color changes in the transplant were recorded by comparing the color of the transplant with the colors on a Tallqvist haemoglobinometer and turning the recording dial to the appropriate percentages. The fluctuations in the color of the transplants could thus be graphically recorded.

THE MODIFICATION INDUCED BY
FOLLICULAR HORMONE

When 20 rat units per kilogram of follicular hormone are injected into a rabbit the following modification of the uterine vascular rhythm occurs. Within 10 minutes the color of the transplant is noticeably intensified and within 15 minutes the transplant becomes 20 per cent redder. In 20 minutes a slight irregularity of the cycle develops and the ratio of the

time in vasoconstriction to that in vasodilation is greater than 1:6. Thirty minutes after the injection of follicular hormone the ratio is 1:10 or greater. These modifications in the vascular cycle continue until 40 minutes after the injection when the rhythmic vascular changes cease and the color of the transplant is comparable to that of 50 per cent haemoglobin.

The injection of follicular hormone that has been extracted from the urine of pregnant women also arrests the rhythmic vascular changes in vasodilation. The method of extracting the follicular hormone from the urine is only slightly different from the one described by Frank and Goldberger (1930) and consists of shaking 150 cubic centimeters of urine with 100 cubic centimeters of ether in a separatory funnel for 30 minutes, drawing off the ether and repeating the extraction with a second sample of ether. The two samples of ether are combined and evaporated to dryness at room temperature under reduced pressure. The residue is dissolved in olive oil and injected subcutaneously. Since the extraction of the follicular hormone by this method requires only 1 hour and 10 minutes and the modification of the vascular rhythm occurs 40 minutes after the injection of the extract, the test may be completed in 2 hours.

Since the rhythmic vascular changes in endometrial transplants onto the iris are arrested by the presence of large amounts of follicular hormone in the blood stream, they are arrested either when follicular hormone is injected or when it enters the blood stream from the rabbit's own ovaries (Markee 1929). The vascular rhythm in the endometrial transplants onto the iris is therefore arrested in vasodilation 7 to 8½ hours after mating or the intravenous injection of urine from pregnant women. The modification of the vascular rhythm, which occurs at that time, is similar in respect to the modification that follows the injection of follicular hormone.

¹ Aided by a grant from the National Research Council Committee on Research in Problems of Sex.

THE DIRECT METHOD OF TESTING FOR PREGNANCY

The direct test has a number of advantages over the indirect one. Either gonadectomized or non-gonadectomized males or females may be used. The possibility exists that the non-ovariectomized rabbit may at times produce a sufficient amount of follicular hormone to cause a modulation of the vascular rhythm in the endometrial transplants, but this is remote because the rabbit apparently does not ovulate spontaneously. Since a kymographic record is made of the uterine vascular changes immediately before the extract is injected, this possible source of error is eliminated. The main advantage of the direct over the indirect test is that the diagnosis can be made 40 minutes after the injection or 2 hours after the specimen of urine has been obtained. Only a limited number of animals are required since the same rabbit may safely be used every third day. A correct diagnosis of pregnancy by both the direct and indirect methods was made as early as the forty-seventh day after the beginning of the last menstrual flow.

Mazer (1930) states that although follicular hormone is not present in the blood in increased concentration during the first 8 weeks of pregnancy it is present in the urine during that period. He suggests that the reason for its elimination through the kidneys may be that it is injurious to the conceptus during the early stages of development. This hypothesis is supported by Kelley's (1931) finding that, in the guinea pig the injection of follicular hormone during the first 4 weeks of pregnancy causes abortion. Bland (1932) found that the Mazer test for pregnancy (based on an increase in the amount of follicular hormone in the urine) was as reliable as the Aschheim-Zondek test. Therefore, it would seem reasonable to suppose that a reliable diagnosis may be made as early in pregnancy by the direct method as by the Aschheim-Zondek method.

THE INDIRECT METHOD OF TESTING FOR PREGNANCY

Only non-ovariectomized females can be used in the indirect test. Since the intravenous injection of urine from pregnant women induces pseudo-pregnancy the animals should

not be used oftener than every third week. The diagnosis can not be made until 7 to 8½ hours after the injection of the urine. These unavoidable disadvantages in the use of the indirect test are compensated for by the fact that it is more easily made since untreated urine is injected. Since a record is made of the vascular changes in the endometrial transplants immediately before the urine is injected, it is definitely known whether or not the animal may safely be used. It is, of course possible that ovulation might be initiated by the handling of the animal at the time that the injection is made. However, since no one who has used the Friedman test for pregnancy has reported such an occurrence this does not seem to be a serious or a probable source of error.

The Cohnheim method of transplantation into the eye (1877) is not a difficult one and the time spent preparing the animals is not important since the same animal is used repeatedly. A further saving of time is effected since it is not necessary to perform an exploratory operation either to determine whether the animal will be a reliable indicator or to make the diagnosis.

The greatest difficulty encountered in the use of these tests for pregnancy is inherent in both methods. As previously reported (Markee, 1932) the vascular changes observed in endometrial transplants in the anterior chamber of the eye are of two kinds: the rhythmic changes and those that follow fright. The former are arrested in vasodilation by follicular hormone but the latter are not. However follicular hormone causes a decrease in the intensity of the vasoconstrictions that follow fright. Hence the diagnosis is more reliably made, if the animal is observed under conditions that eliminate fright. To this end it is placed in a small box, three sides of which are tall enough so that it can not see over them. Since the presence of the observer seems to excite a rabbit especially if he stares into its eye, the best results are obtained by using a microscope that magnifies three times and has a focal length of about 30 inches.

In rabbits without an increased amount of follicular hormone, a vasoconstriction is induced only when the animals are frightened

during the middle third of a vascular cycle. However, if the vascular cycles have been lengthened or arrested by the injection of follicular hormone, fright may induce a vasoconstriction in one of two transplants in one eye and not in the other.

Because of these facts, it is sometimes difficult to decide whether the vasoconstrictions observed are induced by fright or not. It has therefore been necessary to devise some method by which the observer may distinguish between the vasoconstrictions induced by fright and the spontaneous rhythmic vascular changes. The two kinds of vascular changes may easily be distinguished because a vasoconstriction occurs in the blood vessels of the ears 17 seconds after a rabbit is frightened. Hence vasoconstrictions that occur in the endometrial transplants at about the same time as the vasoconstrictions in the ear are fright vasoconstrictions and those that occur in the transplant alone are rhythmic vascular changes. During pregnancy tests the fright vasoconstrictions are ignored since they are not rhythmic vascular changes and are not completely inhibited by follicular hormone.

Specimens of urine from 147 pregnant and 26 non pregnant women were tested by both the direct and indirect methods and all of the diagnoses have agreed with the clinical histories. Veler and Doisy (1928) have shown that the amount of follicular hormone in the urine of pregnant women increases as pregnancy progresses. We have found that enough follicular hormone to effect the modification of the uterine vascular rhythm can be extracted from smaller amounts of urine as pregnancy progresses. However, since we have not used 24 hour samples, it has not been possible to compare our results with theirs nor to discover how small an amount of urine from a woman in the later months of pregnancy will evoke the reaction.

Both the direct and indirect tests for pregnancy are based on the modification of the vascular rhythm in endometrial transplants by the presence of relatively large amounts of follicular hormone in the blood stream of the test animals. The direct test is made by injecting the follicular hormone that has been extracted from 150 cubic centimeters of urine

That volume of urine has been used in all tests because it was not possible to extract enough follicular hormone from 150 cubic centimeters of urine from non pregnant women to arrest the rhythmic vascular changes in the endometrial transplants and because 150 cubic centimeters of urine from pregnant women yields enough follicular hormone to arrest the vascular rhythm.

In all probability, only part of the follicular hormone in the urine was extracted by the method that was used. However, the efficiency of the method of extraction determines only the amount of urine that is used, since if a high percentage of follicular hormone were obtained, less urine would be required to yield enough follicular hormone to arrest the rhythmic vascular changes in the endometrial transplants.

Although all the diagnoses made by the direct method have agreed with the clinical histories, it should be pointed out that if for any reason large amounts of follicular hormone should be present in the urine of non pregnant women, the rhythmic vascular changes would be arrested in vasodilation and so a false diagnosis of pregnancy would be made. This method is merely a test for the presence of increased amounts of follicular hormone in the urine and is only indirectly a test for pregnancy. It should also be pointed out that it is not definitely known just how soon after conception there is a marked increase in the amount of follicular hormone in the urine. Therefore, only experience will determine whether or not this method will reliably test for early pregnancy.

A considerable amount of time is spent extracting the follicular hormone from the urine since if it is not done by hand, the mixture of urine and ether will become foamy. This will sometimes happen no matter how carefully the extraction is made. For these reasons, the direct test may prove to be less satisfactory than the indirect one even though the diagnosis of pregnancy may be made 2 hours after the specimen has been obtained.

Although these two methods of arresting the rhythmic vascular changes in the endometrial transplants have so far been used only as tests for pregnancy, the direct method

might be used as a test for increased elimination of follicular hormone through the kidneys or for the presence of increased amounts of follicular hormone in the blood. The indirect method might be used as a test for increased amounts of hypophyseal hormone either in the urine or in the blood.

SUMMARY

1 The modification of the rhythmic vascular changes in endometrial transplants onto the iris that is induced by the injection of follicular hormone extracted from the urine from pregnant women, can be used as a test for pregnancy. The diagnosis of pregnancy can be made 2 hours after the specimen of urine has been obtained.

2 The intravenous injection of urine from pregnant women causes an increased production of follicular hormone and indirectly in-

duces a modification of the uterine vascular rhythm in the endometrial transplants. By means of this indirect test the diagnosis of pregnancy can be made 8½ hours after the urine has been injected.

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THE COMPARATIVE BACTERICIDAL ACTION OF MERCUROCHROME AND IODINE SOLUTIONS USED AS LOCAL TISSUE DISINFECTANTS¹JAMES STEVENS SIMMONS² WASHINGTON

Major M. C. U. S. Army

IT IS the purpose of this paper to present experimental data concerning the relative bactericidal value of such mercurochrome and iodine solutions as are commonly used locally for the purpose of sterilizing the unbroken skin, oral mucous membranes, abrasions and both superficial and deep wounds.

The present report deals with the continuation of a study of local tissue antiseptics which was begun several years ago at the request of the Medical Supply Division of the Office of The Surgeon General U. S. Army. One of the original aims of the investigation was to answer a hypothetical procurement question as to whether some locally produced tissue disinfectant might not be found suitable to replace tincture of iodine if for any reason it should become difficult for the Army to obtain iodine from the usual foreign sources. Mercurochrome 220 soluble was selected as one of the substances to be studied, mainly because of its popular use as a general antiseptic and because of certain enthusiastic claims made concerning its supposed germicidal value.

In the earlier work with mercurochrome the author (10) determined its germicidal action on several representative species of pathogenic bacteria which might be encountered as contaminants on the unbroken skin while Rodriguez (6) studied its effect on the normal bacterial flora of the oral mucous membranes. The results of these two investigations which were published simultaneously in 1928 may be briefly summarized as follows. In the author's work three types of mercurochrome solutions were used (2 per cent aqueous, 2 per cent alcohol acetone aqueous and 5 per cent alcoholic) also two solutions of iodine (the U. S. P. tincture, 7 per cent and half strength tincture 3.5 per cent) for different time intervals on living skin contaminated with a variety of pathogenic organisms including *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus scarlatinae*, *Escherichia*

coli, *Clostridium welchii* and *Bacillus anthracis* respectively. Bactericidal action was estimated by preparing from each area of treated skin a series of carefully controlled cultures to determine whether the specific test organisms had been killed. From this work it was shown that while the mercurochrome solutions had some antibacterial action *in vitro* against the non-sporogenous organisms they were ineffectual even under these conditions against the spores of *Clostridium welchii* and that regardless of the type of organism its action was relatively weaker than that of tincture of iodine. The relative ineffectiveness of mercurochrome was emphasized still more strikingly by the results of the experiments in skin disinfection. In some instances the 5 per cent alcoholic solution of mercurochrome caused a reduction in the number of bacteria but in 45 of 46 tests it failed to sterilize the skin; the 2 per cent acetone alcohol aqueous solution also caused some numerical reduction of the organisms in certain tests but it too failed in 45 of 50 tests while the 2 per cent aqueous mercurochrome solution failed to sterilize the skin in 55 of 56 tests. Considering these results as a whole it is apparent that mercurochrome sterilized the skin in only 7 or 4.8 per cent of 145 tests and that it failed in 95.2 per cent. In contrast to these results the half strength tincture of iodine caused a reduction in viable organisms in 20 of 42 tests and sterilized the skin in the other 22 tests. The U. S. P. tincture of iodine failed only 7 times—in 2 tests with *Staphylococcus* and in 5 tests with *Clostridium welchii* spores—and in these 7 tests the numbers of viable organisms were reduced. Tincture of iodine was found to be effectively bactericidal in 51, or 87 per cent, of the 58 tests. These carefully controlled experiments which showed that the mercurochrome solutions used were relatively too ineffectual to be of practical value for the destruction of the 6 species of pathogenic bacteria present as con-

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taminants on living skin led to the conclusion that mercurochrome was not suitable for use as a substitute for tincture of iodine in pre operative skin disinfection.

Unfavorable results were also obtained with mercurochrome by Rodriguez in his experimental investigation of this drug as a pre operative disinfectant for use on the oral mucous membranes. His conclusions were as follows: Mercurochrome 220 soluble (2 per cent aqueous solution) is too feeble an antiseptic to be used safely as a surface disinfectant of the oral mucous membranes. The 5 per cent mercurochrome solution in alcohol and the mercurochrome-alcohol acetone preparations possess decided advantages over the aqueous solution, but fail in too large a proportion of cases to be considered effective in surface disinfection of the oral mucous membranes. Iodine in 3.5 per cent and even in 1.75 per cent strength, preferably in glycerin is an effective germicide from the standpoint of surface disinfection of the oral mucous membranes.

These observations have since been confirmed by other workers although there was some disagreement on the part of Reddish and Drake and later by Scott, Hill and Ellis (9). The former in an article which appeared simultaneously with those by Rodriguez and the author published experiments in which, by a different technique, mercurochrome and iodine were tested for disinfectant action on rabbit skin contaminated with a strain of *Staphylococcus aureus*. In this paper Reddish and Drake (5) claimed that a 2 per cent mercurochrome in aqueous-alcohol-acetone solution and tincture of iodine are equally effective in disinfecting the unbroken skin but it appears that their conclusions were not warranted by their published results, even with the one species of bacteria considered. Moreover these writers failed to support their broad conclusions by tests with the other important pathogenic skin contaminants. Also no mention was made of the fact that one of them (Reddish, 4) had previously stated in official individual reports from his laboratory in the Department of Agriculture, copies of which were furnished me, that, even *in vitro* mercurochrome was ineffective against such

spore forming bacteria as *Clostridium welchii* and *Clostridium tetani*. In one of these official reports made in 1925 Reddish stated that

Clostridium tetani is not killed by 5 per cent aqueous or 5 per cent alcoholic mercurochrome in 2 hours. Tincture of iodine kills it some time between 30 minutes and 1 hour but close to 30 minutes because it shows a \mp at 30 minutes. In another such report he showed that 5 per cent alcoholic mercurochrome failed to kill the Welch bacillus, *in vitro* in 2 hours, while *Clostridium welchii* is practically killed after 15 minutes exposure to tincture of iodine

and certainly entirely all killed by 30 minutes exposure. The following remark was added: *Tincture of iodine is decidedly better than 5 per cent alcoholic mercurochrome against Clostridium welchii the commonest of the war wound anaerobes*. The obvious discrepancies between these observations made by Reddish in 1925 and the conclusions published by Reddish and Drake in 1928 without any mention of *Clostridium welchii* or *Clostridium tetani* appear to detract considerably from the value of their statements on skin disinfection.

DeLafield in reviewing these publications (5, 6, 10) commented as follows on the report by Reddish and Drake: Adopting a somewhat different technique to that used by J. S. Simmons (*supra*), conclusions are reached which are at variance with those of the latter investigator. Only one test organism was used—*Staphylococcus aureus* 209—and the bacteriological method was different. The 2 per cent alcohol acetone-aqueous solution of mercurochrome is said to be as effective as tincture of iodine, and, because of the well known objections to the latter to be far more suitable for skin disinfection. (The tabular statement of results does not appear to justify this sanguine view of the efficacy of mercurochrome.)

Sinclair in a report to The Surgeon General, U. S. Army dealing with his experimental studies of tissue disinfectants, made the following statement concerning mercurochrome:

In support of previous complete report by Major James S. Simmons and to controvert the editorial (2) criticism of his technique in the *Journal of the American Medical Association* September 8, 1928 a test was made, the

technique of Dr. G. I. Reddish being used. Methods and results are included in Protocol I enclosed. This experiment supports the previous report of Major Simmons that mercurochrome is not an effective substitute for iodine in skin disinfection. Although these results were obtained after strictly following the technique of Reddish (4) they are strangely diametrically opposite to results obtained by him. However they agree very closely with those obtained by Simmons from which he drew the following conclusion:

From the standpoint of bactericidal action tincture of iodine is far superior to any of the solutions used (mercurochrome) on unbroken skin for disinfection purposes.

In 1929 Scott Hill and Ellis (9) published an article in defense of the 2 per cent aqueous alcohol acetone solution of mercurochrome which had been presented as a pre-operative skin disinfectant in 1925 by Scott and Hill (8) who had made the claim that better skin sterilization is obtained with it than with iodine. While the more recent article dealt mainly with controversial matter it also included the results of disinfection tests with (a) unwashed human skin the bacterial contamination of which was necessarily variable as to quantity and species and (b) with disinfection of shaven rabbit skin contaminated by applications of 24 hour broth cultures of *Staphylococcus aureus* 209. It will be noted that the latter method of preparing the skin contamination is essentially similar to that outlined in their original report in which they stated that the shaven rabbit skin was heavily inoculated by smearing it with 18 hour 1 per cent dextrose broth cultures. This point is emphasized only because of the marked disagreement between the results reported by Scott and Hill in 1925 and those by Scott Hill and Ellis in 1929. In the earlier article the tabular results indicated that within 2 $\frac{1}{2}$ or even 1 minute a time the 2 per cent mercurochrome solution caused complete sterilization of skin contaminated with such heavy inoculations of *Staphylococcus aureus* in all of 25 tests. However according to the 1929 report the same type of mercurochrome solution applied for 5 or more minutes to rabbit skin similarly contaminated with 24 hour broth cultures of

Staphylococcus failed to sterilize the skin and the cultures showed heavy growth of *Staphylococcus aureus* in 100 per cent of the 1 tests. In 9 parallel skin tests with tincture of iodine the cultures also showed heavy growth and 2 were recorded as sterile. In the later article the authors concluded that the two drugs were equally effective in sterilizing the uncleaned human skin but no explanation was offered for the modification of their earlier claim concerning the supposed superiority of mercurochrome or for the discrepancies in their various published results. These claims by Scott Hill and Ellis which agree in substance with those of Reddish and Drake are subject to similar objections and obviously cannot be accepted on the experimental evidence offered.

In 1931 Scott and Birkhaug (7) reported the results of an investigation made to determine the relative bactericidal value of certain skin disinfectants including (a) metaphen (0.5 per cent in alcohol acetone solution) (b) tincture of iodine (7 per cent) and (c) mercurochrome (2 per cent in alcohol acetone solution). Each solution was used in 104 three minute tests including both surface and deep disinfection tests on unwashed human skin and in 125 three minute tests with rabbit skin contaminated with undiluted 18 hour broth cultures of *Staphylococcus aureus*, *Streptococcus hemolyticus*, *Bacillus coli* and *Bacillus subtilis* (spores) respectively. The results were determined by a technique somewhat similar to that used in my investigations mentioned above. After 3 minutes treatment of the skin cultures were made with two moistened cotton swabs which were first rubbed vigorously against the center of the treated area and then immersed in 100 cubic centimeters of Douglas broth contained in a 250 cubic centimeter Erlenmeyer flask. After incubation for 48 hours at 37 degrees C the results of skin sterilization were determined according to the growth of bacteria in the test cultures. Their results were as follows. In the surface tests with rabbit skin heavily contaminated with undiluted 18 hour broth cultures of *Staphylococcus aureus*, *Streptococcus hemolyticus*, *Bacillus coli* and the spore bearing *Bacillus subtilis* metaphen killed the organisms in 89.7 per cent tincture of iodine



Fig. From Report to The Surgeon General, U. S. Army by Major Charles G. Sinclair, M. C. Department of

Bacteriology Army Medical School, Washington, D. C. September 1928.

in 70.7 per cent and mercurochrome in 51.5 per cent of the tests. The results in the deep sterilization tests on rabbit skin contaminated with the same species of bacteria were as follows: metaphen 87 per cent, tincture of iodine 47 per cent, and mercurochrome 26 per cent. In the disinfection tests on the surface of normal human skin, metaphen was effective in 98 per cent, tincture of iodine 96.1 per cent, and mercurochrome in 28.8 per cent of 52 tests each. In the deep tests on human skin epithelial scrapings being used, metaphen produced sterility in 94.2 per cent, tincture of iodine in 84.6 per cent, and mercurochrome in 3.8 per cent of 52 tests each. Although no experiments were reported with *Clostridium welchii* or *Clostridium tetani*, this investigation by Scott and Birkhaug again confirms the earlier conclusions of Simmons, Sinclair and others, concerning the relative ineffectiveness of mercurochrome as a skin disinfectant.

More recently Kelsor and Mohri have reported the results of experiments from which

they concluded that the commonly marketed 2 per cent solution of mercurochrome 220 soluble is not a satisfactory skin disinfectant for use in veterinary practice. Compared with tincture of iodine (U.S.P.) for such purpose, the latter proved superior. A concentration of 1 part of tincture of iodine (U.S.P.) in 10 parts of a suspension of tetanus spores killed the spores within 10 minutes. A similar concentration of mercurochrome (2 per cent aqueous) failed in this respect. Mercurochrome is decidedly ineffective as a germicide in the presence of blood serum, tissue exudates and possibly other protein substances. Such substances interfered much less with the bactericidal action of tincture of iodine.

Thus the available experimental data indicates that while mercurochrome possesses some antiseptic action against certain organisms *in vitro*, its obvious limitations are such that it need not be considered further as a substitute for iodine in disinfection of the mucous membranes or skin.

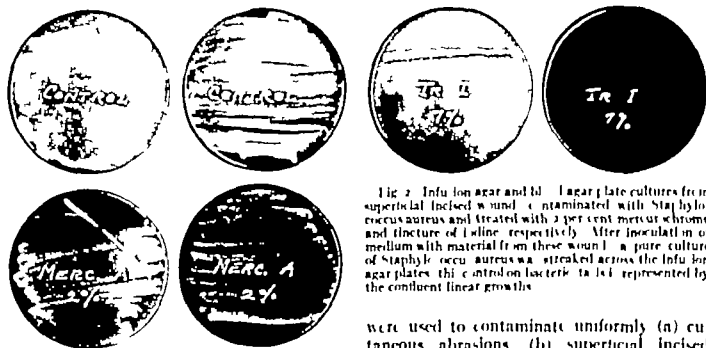


Fig. 2. Infusion agar and (b) T agar plate cultures from superficial incised wound contaminated with *Staphylococcus aureus* and treated with 2 per cent mercurochrome and tincture of iodine respectively. After inoculation of medium with material from these wounds a pure culture of *Staphylococcus aureus* was streaked across the infusion agar plates; the control on bactericidal represented by the confluent linear growths.

PRESIDENT INVESTIGATION EXPERIMENTAL

The results of previous experiments showing mercurochrome to be of relatively little value for pre-operative skin disinfection suggested that the drug might be even less effective in the presence of such proteins as are to be encountered in wounds. However because of certain unsubstantiated claims concerning the supposed effectiveness of mercurochrome under these conditions the investigation was continued to include this phase of the subject.

Materials and methods. Several different solutions of both mercurochrome and iodine were tested as wound disinfectants but a large proportion of the experiments were done with a commercially prepared solution labeled

Mercurochrome 2 per cent solution dibromoxymercuri fluorescein general antiseptic in place of iodine. Tincture of iodine was used in parallel control tests. These two solutions were selected purposely because both are commonly used as local applications on abrasions and superficial wounds. The bacteria considered in this report are *Staphylococcus aureus* and *Streptococcus pyogenes*. Because of the consistent resistance of these organisms to mercurochrome the original plan to include species of spore forming bacteria was considered unnecessary. As in the experiments on skin disinfection broth cultures or saline suspensions of the test organisms

were used to contaminate uniformly (a) cutaneous abrasions (b) superficial incised wounds and (c) deep incised wounds made through the shaven abdominal skin of rabbits. The animals were immobilized on boards throughout the experiments. Sterile towels were used to protect the wounds in the tests requiring long exposure and the necessary precautions against accidental contamination were observed. Within 5 minutes after adding the bacteria the antiseptic solutions were applied to the contaminated wounds and to the adjacent skin for the desired periods of time varying from 5 minutes to 3 hours. Cultures were then made to detect the survival of any viable test organisms by collecting materials from each wound on moist sterile cotton swabs which were immediately rubbed over the surfaces of blood agar serum agar or nutrient agar plates and then used to inoculate flasks containing 100 cubic centimeters or more of beef infusion broth pH (7.4 to 7.6). In each experiment parallel cultures were made in a similar manner from untreated wounds to furnish a comparison with results obtained in the tests and as usual adequate controls were made to eliminate the possibility of confusion due to bacteriostasis in the test cultures. In a large number of experiments conducted under a variety of conditions the following results were obtained.

1. *Disinfection of contaminated abrasions of the skin.* As indicated in Table I a total of 42 skin abrasions 30 contaminated with *Staphy-*

TABLE I—DISINFECTION OF ABRASIONS OF RABBIT SKIN

	Duration of wound treatment (minutes)	Number of wounds treated with each drug	Number sterile after treatment with	
			per cent aqueous Mercurchrome	Tincture of iodine
A. Contaminated with <i>Staphylococcus aureus</i>	5	8	None	5
	30	6	None	5
	30	9	None	5
B. Contaminated with <i>Streptococcus pyogenes</i>	5	6	None	3
	60	3	None	
	30		None	5
Totals		42	None	31
Percentage of complete sterilization				86

lococcus aureus and 12 with *Streptococcus pyogenes*, were treated with mercurochrome. Cultures made from these treated lesions after 5, 30 and 120 minutes showed growth of the test organisms as follows: In one test with *Staphylococcus aureus* there was one colony, in 2 there were 30 colonies while in the remaining 39 tests the growth was as luxuriant as in cultures from the untreated control abrasions. In the parallel series of 42 abrasions treated with tincture of iodine 8 showed growth of the test organisms in cultures as follows: four showed about one fourth as much growth as the controls, two had 25 colonies each, one had 23 colonies and one had 3 colonies. All cultures from the remaining 34 abrasions were sterile. Thus it is apparent that while mercurochrome caused very little reduction in the numbers of contaminating organisms and failed to sterilize any of the wounds, tincture of iodine resulted in sterilization in 80.9 per cent of the abrasions and in the remaining 8 caused a numerical reduction in the test organisms.

II *Disinfection of contaminated superficial incised wounds.* The results obtained in bactericidal tests with superficial incised wounds are indicated in Table II. The 2 per cent aqueous solution of mercurochrome used on 89 such wounds contaminated with *Staphylococcus aureus* caused some numerical reduction of the organisms in 58 instances. In 23 of these tests the growth was about half as luxuriant as on control plates, in 10 it was esti-

TABLE II—DISINFECTION OF SUPERFICIAL INCISIONS OF RABBIT SKIN

	Duration of wound treatment (minutes)	Number of wounds treated with each drug	Number sterile after treatment with		
			per cent aqueous	per cent alcohol-acetone-water	Iodine U.S.P. tincture
A. Contaminated with <i>Staphylococcus aureus</i>	5	4	None		23
		3	None		
	5	2	None		6
	30	9	None		2
	60		None		
	70	5	None		4
	70		None		8
	80		None		
B. Contaminated with <i>Streptococcus pyogenes</i>	5	9	None	None	7
			None	None	
	30			None	7
			None		
	60	5	None	None	5
	30		None		4
	40			None	4
Totals		41	None	None	50
Percentage of complete sterilization					8

ated at one-fourth while in 2 tests there were 5 and 10 colonies respectively. Cultures from the remaining 31 wounds showed luxuriant growths similar to those obtained from untreated control wounds. This solution of mercurochrome used on 14 wounds contaminated with *Streptococcus pyogenes* failed to cause any appreciable decrease in the numbers of test organisms. Slightly better results followed the use of 2 per cent mercurochrome solution in water, alcohol and acetone on 21 wounds contaminated with *Streptococcus pyogenes*. In 8 of the tests there was some reduction in growth, 3 were reduced about one half, one to about one-fourth while 4 others showed 1, 2, 7 and 50 colonies respectively. In the 13 remaining tests, the bacterial growths were luxuriant, resembling in amount the cultures from untreated wounds. Considering the results with mercurochrome as a whole, this drug was used on a total of 124 contaminated wounds, none of which was sterilized. Tincture of iodine used similarly on 124 wounds gave the following results:

Cultures from 89 wounds contaminated with staphylococci showed that 64 were sterile while those from the remaining 15 showed a reduction in living organisms. In one there were 80 colonies in 3 less than 50 in 4 less than 25 and in 7 less than 10 colonies each. Cultures from the 35 wounds contaminated with streptococci gave essentially similar results. Seven showed reduced growths 1 had 80 colonies 3 less than 50 and 3 less than 10 colonies each while all cultures from the remaining 28 wounds were sterile.

To recapitulate mercurochrome failed to sterilize any of the 124 superficial incised wounds in which it was used while tincture of iodine was effective in 103 or 83 per cent.

III *Disinfection of contaminated deep incised wounds.* The 2 per cent aqueous solution of mercurochrome was used on 32 deep incised wounds contaminated with *Staphylococcus aureus* and on 12 contaminated with *Streptococcus pyogenes* with the results shown in Table III. Cultures from these 44 treated wounds showed luxuriant growths of the test organisms and there was no apparent numerical reduction except in 3 tests recorded as +++ and + respectively. After treatment with tincture of iodine cultures from 7 wounds showed a reduction of one half (++) 11 tests showed a reduction of one fourth (+) in 1 test there were 80 colonies in 2 there were 30 colonies each and in 4 there were 10 colonies or less. Cultures from the remaining 19 or 43.1 per cent of the wounds were sterile.

TABLE III—DISINFECTION OF DEEP INCISIONS OF RABBIT SKIN

	Duration of wound treatment (minutes)	Number of wounds treated with each drug	Number sterile after treatment with	
			per cent aqueous mercurochrome	Tincture of iodine
A. Contaminated with <i>Staphylococcus aureus</i>	5		None	4
	60	5	None	5
	20	6	None	5
B. Contaminated with <i>Streptococcus pyogenes</i>	5	6	None	2
	60	5	None	3
	120	5	None	3
Total		4	None	9
Percentage of complete sterilization		0		43

SUMMARY

1 Three types of wounds—skin abrasions superficial incisions and deep incisions—contaminated with undiluted broth cultures of either *Staphylococcus aureus* or *Streptococcus pyogenes* were treated for various periods of time with solutions of iodine and mercurochrome respectively.

2 Application of tincture of iodine to 151 wounds contaminated with staphylococci resulted in sterile cultures as follows: abrasions 83.4 per cent superficial incisions 83.1 per cent and deep incisions 31.2 per cent while its use on 59 wounds contaminated with streptococci resulted in sterilization as follows: abrasions 75 per cent superficial incisions 80.9 per cent and deep incisions 8 per cent. In brief of 210 contaminated wounds treated with tincture of iodine the cultures from 156 or 74.2 per cent were sterile.

3 Mercurochrome used under similar conditions caused relatively little reduction in the numbers of viable test organisms and failed to sterilize any of the 210 wounds.

CONCLUSION

The 2 per cent aqueous solution of mercurochrome advocated for the first aid treatment of wounds is a relatively weak antiseptic. When used experimentally for the destruction of *Staphylococcus aureus* or *Streptococcus pyogenes* in abrasions or incised wounds it was decidedly less bactericidal than tincture of iodine. Mercurochrome is comparatively so ineffective in the sterilization of contaminated living tissues that it should not be considered as a substitute for iodine.

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EXCRETION UROGRAPHY BY MEANS OF THE INTRAVENOUS AND ORAL ADMINISTRATION OF SODIUM ORTHO-iodoHIPPURATE WITH SOME PHYSIOLOGICAL CONSIDERATIONS¹

PRELIMINARY REPORT

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ALTHOUGH the original contribution to excretion urography with the use of Iopax (uroselectan) as described by the author (11) has proved useful in the clinical investigation of the urinary tract (7) certain desirable features have been wanting. The present paper deals with another substance¹ newly developed for excretion urography and is based upon the physiological principle of detoxification and on other metabolic considerations. The fundamental concept of this work is the utilization of an organic nucleus representing a normal product of animal metabolism, as a carrier for the radiopaque element necessary for the X-ray visualization of the urinary tract. The compound now proposed is sodium ortho-iodohippurate a halogen derivative of a substance normally found in the human urine.

In the consideration of a new substance to be used for excretion urography the following were the guiding principles:

- a. That the substance be highly soluble and approximate the hydrogen ion concentration of the blood.
- b. That the radiopaque halogen be bound in a stable form to an organic nucleus.
- c. That the nucleus be one which is produced in the course of animal metabolism.
- d. That it be highly water soluble. A high degree of water solubility is generally paralleled by a greater tendency for rapid absorption and excretion and also permits the intravenous administration in small volume. Moreover a substance that is readily and rapidly excreted from the body is less apt to produce toxic manifestations. In this connection it is also important to note that organically bound iodine for excretion urography has been found to be well tolerated by the human

body and not associated with the picture of iodism.

e. That the substance be a sodium salt, since the sodium ion is most suitable from a physiological standpoint.

f. That the substance be selectively and rapidly excreted by the kidney in high concentration.

g. That it be well tolerated.

h. That it be comparatively inexpensive.

Of the metabolic studies already reported concerning benzoic and hippuric acids the following points appeared noteworthy and promising in the development and rationale of the present investigations:

a. The introduction of benzoic acid or its sodium salt into the animal organism results in its conjugation with glycine and in the excretion of hippuric acid or its sodium salt in the urine. In similar fashion it has been shown that the administration of iodobenzoic acid in the dog and rabbit results in the urinary excretion of iodohippuric acid (Novello, Miriam, and Sherwin).

b. The synthesis and elimination of hippuric acid after benzoic acid administration represent processes of detoxification (Caonka, Griffith and Lewis, Ralzius and Dubin, Lewinski, Dakin and Lewis).

c. Sodium hippurate is a very suitable organic parent substance for combination with iodine or bromine since (1) it is extremely soluble in water (2) is neutral in solution (Corbield and Melhuish) (3) represents a product of metabolism (4) is well tolerated and (5) is quantitatively excreted (95 per cent) in 6 hours after the intravenous administration to the rabbit (Ralzius, Ralzius and Ringer, Griffith and Lewis, Caonka, Lewis).

With these observations and considerations in mind and after consultation with Dr. Sobotkin to whom thanks are expressed for his

¹This new medium for excretion urography is as yet not procurable for general use.

From the Second Surgical Service, the Radiographic and Laboratory Divisions, the Mount Sinai Hospital, New York. Work carried out with the aid of a grant from The Edmund Liberman Fellowship Fund.



Fig. 1 Intravenous urogram man, 38 years old. Normal primary tracts. 10 grams of substance administered.



Fig. 2 Oral urogram man, 32 years old. Dilatation of both kidney pelves. Kinking of right ureter. Underlying condition—urethral stricture. Fifteen grams of substance administered.

kind co-operation the author carried out a series of experiments resulting finally in the demonstration that sodium ortho-iodohippurate possesses the necessary qualifications.

In accordance with the present investigations this substance proves to be a non toxic highly soluble neutral and radiopaque salt which is selectively excreted through the urinary tract in sufficiently high concentration to yield satisfactory urograms.

Sodium ortho-iodohippurate (38.8 per cent iodine) is easily soluble in less than its own weight of water and can be prepared and distributed in sterile solution ready for use. The solution remains unchanged in color or reac-

tion after sterilization or on standing. The iodine exists in a stable organically bound state. Iodism has never been observed. The tolerance for this compound is good. Rabbits usually tolerate 2 to 2.5 grams of substance per kilogram of body weight administered intravenously in 30 per cent concentration over a period of about 10 minutes. Patients suffering from tuberculosis or Graves' disease have not shown reactions after injection. Manifestations of injury to the kidney as demonstrated by urine analysis in the human as well as tissue examination in the rabbit have not been observed. Microscopic examination of the liver, lung and heart similarly fails to reveal evidences of injury. The tissues selected for examination have been obtained from rabbits killed 24 hours to 4 months after injection. The substance is excreted as such through the urinary tract and may be recovered as the insoluble acid on the addition of a dilute mineral acid. On recrystallization from hot water with the aid of charcoal the recovered sub-

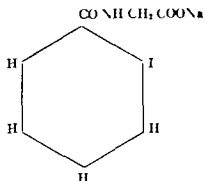
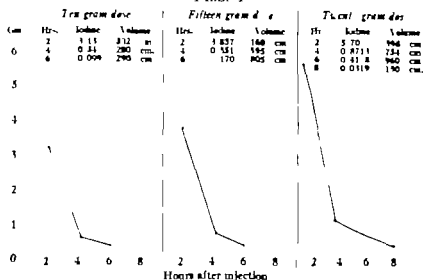


TABLE I



stance appears white and crystalline. Identification of this substance has been accomplished by means of melting point, nitrogen and iodine determinations. The urines from patients injected with sodium ortho-iodohippurate have never shown positive Fehling or Benedict reactions, indicating that the formation of iodo-benzoic acid and its subsequent excretion and conjugation with glycuronic acid is unlikely. Furthermore, the quantitative determinations of the recovered substance would speak against the presence of either excreted free iodobenzoic acid or iodobenzoyl glycuronic acid.

Normally from 90 to 95 per cent of the substance can be recovered from the urine within 8 hours after the injection (based upon iodine determinations). Between 70 and 80 per cent (in terms of iodine) is recovered during the first 2 hours and between 60 and 66 per cent is excreted in the first hour. Table I illustrates the curves of excretion in normally functioning kidneys obtained after the administration of 10, 15 and 20 gram doses respectively. From these results it is evident that the normally functioning kidney excretes this substance in a high concentration and within a short period.

It is evident that a certain concentration of the radiopaque element, the iodine, is necessary for roentgenological visualization.

This concentration depends upon renal and extrarenal factors influencing renal excretion as well as upon the dose administered. Broadly speaking, good visualization, poor or no visualization is dependent upon the above enumerated factors. Other considerations bearing upon the relationship between renal function and roentgenological visualization are discussed in other publications.

Therefore, as in the case of other substances developed for excretion urography, so with sodium ortho-iodohippurate, it is essential to bear in mind the factors governing renal excretion when evaluating this method and the results obtained with it.

Procedure and reactions. Satisfactory urograms have been obtained in adults with doses varying between 10 and 15 grams of substance dissolved in distilled water in 40 per cent concentration. The injection is carried out over a period of 5 minutes. The first film is taken 10 minutes after the injection, two subsequent exposures being made at 20 minute intervals. Whenever functional disturbances are present, additional films should be taken to determine definitely the absence of visualization or the presence of late visualization. Aside from a slight sensation of generalized warmth, there have been no reactions. Thrombosis at the site of injection has not been observed. To date 125 cases have been injected, 20 and 30

grams of substance having been administered in some cases, with the larger dose occasionally transient vomiting occurs. Children under 13 years of age have received 10 gram doses without ill effects. A one year old child in whom suitable roentgenograms were observed, showed no reactions from a 10 gram dose. In a 3 year old child receiving 6 grams of substance satisfactory roentgenograms were also obtained.

Oral administration in the human has given encouraging results. Of 14 cases 50 per cent yielded satisfactory urograms. The dose administered by mouth has been between 10 and 15 grams dissolved in simple syrup. No reactions have been noted. Diagnostic pictures have been obtained 90 and 135 minutes after administration. It appears that the results by the oral route will not be as consistently good as by the intravenous one. Further investigations with the oral administration are in progress in the hope of improving the results.

Of great aid in obtaining clearly defined and readable urograms is the application of a moderate degree of compression by means of an air inflated balloon over the region of the urinary bladder. A more detailed consideration of this aspect is dealt with in other publications.

Field of application and contra indications
In order to avoid repetition the reader is referred to the literature dealing with excretion urography wherein these phases are discussed.

Additional investigations with related substances such as the sodium salts of meta and para iodohippuric acids diiodohippuric acid and of bromiodohippuric acid iodobenzoyl urea, and finally the administration of monoiodo- and diiodobenzoates of sodium in con-

junction with glycine by the intravenous and oral routes are being continued.

SUMMARY

The author presents sodium ortho-iodohippurate for excretion urography. It is felt that this substance has the following advantages:

- 1 It is relatively inexpensive
- 2 It is without toxic effects
- 3 It can be administered in a small volume of diluent
- 4 A relatively small quantity of the salt is required for satisfactory urograms
- 5 It yields satisfactory roentgenograms
- 6 Satisfactory results have been obtained by the oral route

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THE USE OF ANTICOLIBACILLARY SERUM IN SURGERY¹

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I HAVE shown that certain strains of *Bacillus coli* possess both experimentally and in human infection, a considerable virulence and toxicity which in man may be manifested by medical and surgical conditions of great gravity. I have also shown that *Bacillus coli* (the atypical as well as the normal strains) has the power of secreting two toxins, one a neurotropic thermolabile exotoxin, the other an enterotropic and hepatotropic thermolabile endotoxin. The association of these two toxins produces a pathological state that determines the widely varying phenomena which accompany colibacillary septicemias as well as acute or chronic local colibacillary infections. Such a pathological state explains the nervous troubles observed in chronic enteropathies (particularly mucomembranous enteritis) paralyses etc. which are brought about by the exotoxin. The endotoxin affects particularly the glands of Lieberkuehn, the biliary secretion, and the hepatic parenchyma. It produces severe symptoms, such as diarrhoeal crises. The toxic infection may even terminate in icterus gravis or acute yellow atrophy of the liver (H. Vincent).²

My clinical and experimental researches have led me to the preparation of an antitoxic and anti-infectious anticolibacillary serum. This serum injected into patients suffering from very grave medical conditions *Bacillus coli* septicemia, cholecystitis of the same origin, suppurative pyelonephritis (in adults of all ages pregnant women children) chronic enterocolitis, paralyses of colibacillary origin etc. brings about a rapid recovery such as I have already reported.³

Moreover *Bacillus coli* commonly brings about maladies which interest the surgeon in particular. It has therefore, seemed worth

while to point out the effect that this new anticolibacillary serum may produce in affections of a surgical nature.

Few organs escape infections due to the colon bacillus, but in general the abdominal viscera are the ones most frequently affected by this micro-organism because it lives normally in their vicinity i.e. the intestine. The peritoneum on account of traumatism of the intestine (contusion, wounds by penetrating instruments, gunshot wounds, etc.) is frequently invaded by micro-organisms of the digestive tract. One of the most common as well as the most dangerous, is certainly *Bacillus coli*. Perforative or gangrenous appendicitis constitutes equally one of the most important indications for anticolibacillary serotherapy. Pyosalpingitis is the expression of very diverse infections among which those by *Bacillus coli* are very common. The same is true of pelvic abscesses. In all of these affections it is advantageous before injecting the serum, to make a microbiological examination.

Primary suppurative pyelonephritis of *Bacillus coli* origin requires as early application as possible of serotherapy. This malady as I shall show is rapidly cured by this method. In pregnancy and in the puerperium, when the bacillus has invaded the blood and has lodged, as a result, in the renovesical apparatus, the infectious symptoms disappear within a few days. I shall review the principal surgical maladies in which serotherapy serves as a particularly efficacious aid to the surgeon and operator.

Statistics of mortality from gangrenous appendicitis with perforation and late operation indicate a death rate of 7 cases out of 10 (Cook, of Nancy Vielle of Bordeaux) 3 cases out of 6 (Dr. Folsy) 70 per cent (Racovatz) etc.

Gangrenous appendicitis constitutes one of the most important indications for sero-

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therapy.¹ This serum is in fact, a precious adjuvant to surgical intervention. *Bacillus coli* is the agent almost constant in peritonitis so often fatal and in septicaemias of appendicular origin. This bacillus exists on the surface of the appendix and in the pus in prodigious quantities. I have recovered it sixteen times in seventeen cases of gangrenous appendicitis from the cloudy or purulent fluid surrounding the necrotic appendix. The anaerobes *Bacillus perfringens*, *Bacillus fragilis*, *Bacillus funduliformis*, *Bacillus fusiformis* etc. are much more rarely present (about one in four), and in small numbers. Nevertheless before operating in such cases I advise the administration of multivalent antigangrenous serum² or anticolibacillary serum the one or other introduced into the operative field and injected simultaneously under the skin.

This is the technique systematically employed in various surgical services notably at the Val-de-Grâce (Professors Duguet, Clavelin, Paltre, Lacaze and others) by Dr Foisy of Chateaudun by Dr Guibal of Baziers by Professor Forgeue of Montpellier by Professor Laffitte of Niort and other surgeons. This treatment brings about 'ideally simple' recovery (Clavelin). It prevents the too frequent dangers which accompany gangrenous appendicitis with perforation and peritonitis in operations of necessity (Dr Foisy surgeon in chief of the hospital of Chateaudun).

I shall give two examples from among many others.

Louis S. aged 21 years admitted to the Val-de-Grâce, December 3 1928 in the service of Professor Paltre. The onset was 48 hours previously but the symptoms had become markedly worse 10 hours before arrival at hospital and consisted of greenish vomiting hiccough ballooning of the abdomen and generalized contraction of the walls. There had been passage of gas for 10 hours. Intestinal obstruction and general condition were grave. Temperature 103.1 degrees pulse 140 and hardly perceptible. The operation by Dr Lacaze showed the appendix gangrenous in the terminal two-thirds, and ruptured into the peritoneal cavity without any walling off. Small stercoral calculi were found in the free perito-

neum and abundant cloudy foul-smelling fluid in all the peritoneal folds and the pouch of Douglas. The intestinal loops were dilated red and like ground glass in appearance. After operation 60 cubic centimeters of anticolibacillary serum and 20 cubic centimeters of multivalent antigangrenous serum were injected subcutaneously the dose being repeated on the following day. The treatment was continued in diminishing doses and the temperature returned to normal on the fourth day. Six days after operation the drains were removed. Aside from the serum reaction recovery was uneventful.

In this serious case of gangrenous appendicitis with widely diffused peritonitis there followed extremely simple and rapid recovery under the treatment.

In the following case reported to me by Dr Machavoine former interne Hôpitalux de Paris there is another remarkable example. It may be summed up thus:

Treatment of generalized peritonitis after perforation of appendix by Vincent's anticolibacillary serum and hypertonic salt solution. Recovery.

The patient was a young woman of 25 years stricken November 7 1928 with gangrenous appendicitis with perforation of the appendix followed by acute peritonitis. Operation 48 hours afterward was difficult and prolonged (14 hours). The patient was transported in emergency to the clinic by automobile over a rough road 60 kilometers long. The surgical intervention was of necessity done under the most unfavorable conditions. There was present a quantity of foul liquid which flowed out in all directions. The entire appendix was gangrenous and perforated. On the following day November 10 the patient was in a state of profound shock and in extremely grave condition. There were ballooning of the intestines hiccough vomiting fecal retention etc. Pulse was about 110. The usual treatment (glucose solution cardiac tonics etc.) was given but without much hope according to the surgeon 'because the patient seemed lost.'

On November 11 there was administered the first injection of 60 cubic centimeters of anticolibacillary serum which had been procured in all haste from Paris. The injections were continued 40 cubic centimeters being given every 4 hours on November 12 13 and 14. At this time the danger seemed to be over and it was not considered necessary to continue the anticolibacillary serotherapy. As the patient showed signs of intestinal obstruction there were given on November 12 and the two days following intravenous injections of hypertonic salt solution by Grosset's method. 'The situation which had seemed desperate and which was becoming worse, was miraculously transformed (Dr Machavoine). Finally the patient left the surgical clinic on December 2 entirely cured of the serious symptoms which had seemed to point to certain death.'

¹ H. Vincent, J. Méd. Brice, 1925 May; Idem, J. Méd. Montpellier 1916, Nov.; Idem, Internat. Clin., 1916, xxvii, 6; Idem, Progrès médical en Thérapie anti-bactérielle, Paris, J. B. Baillière et Cie, 1916, 6.

² Idem Bull. Acad. de Méd., 1928, 27 and 29, March 10.

H. Vincent and G. Boudet, Compl. rend. Acad. d. Sc., 1928, 8, chviii, 127-128, 309-310, 319, chviii, 183.

Dr Foucault of Poitiers also published a series of observations of appendicitis with perforation and with beginning peritonitis or even with generalized peritonitis which were cured by surgical intervention aided by serotherapy. One of the most remarkable cases was that of a little girl, aged 8 years.

The surgeon saw her for the first time "in a state of diffused peritonitis of appendicular origin," with the abdomen ballooned out, fecal vomiting, pulse 158 and temperature 99 degrees. The case was 48 hours old, and the mother had purged the child the day before. When the abdomen was opened, the peritoneal cavity was found to be full of pus, as were the right iliac fossa, pouch of Douglas, and left iliac fossa. The general condition was very grave. Operation was done under novocain. At the same time anticolibacillary serum was injected. After 24 hours the pulse had dropped to 110 and the general condition so desperate the day before, showed great amelioration. After 48 hours the improvement was even more noteworthy. The pulse was 80. The child recovered. She had, however, been considered as lost, and intervention had been done in extremis.

Dr Laffitte of Niort has reported similar cases to me.

In cases of generalized peritonitis of appendicular origin in which prognosis is fatal, one cannot advise too strongly the injection very early of large doses of serum. 60, 80 or 100 cubic centimeters in adults, 40 cubic centimeters in children, renewing the injections as often as necessary and diminishing the dosage when the general and local conditions are both improving.

These facts demonstrate what great security such serotherapy brings to the surgeon and that one may employ this method in gangrenous appendicitis complicated by localized or even generalized peritonitis.

The same method used in pelvic abscesses, and, in a general way, in neighboring suppurations of the intestine when *Bacillus coli* is present or abundant in the pus, may be of great service to the surgeon. Often such suppurations the point of departure of which is a lesion or traumatism of the digestive tract, are produced by the many micro-organisms from the intestine: anaerobes, enterococci, streptococci and at times even the *Bacillus fusiformis* and *Spirochaeta vincenti*. The presence of the colon bacillus

suggests the use of the anticolibacillary serum, but when anaerobes are associated therewith one must inject simultaneously the multivalent antigangrenous serum of H. Vincent and G. Stodel, as we have advocated in the treatment of gangrenous appendicitis, as well as the new antistreptococcic serum prepared by my method, which is particularly active even in septicemia verified by hamoculture.

Iliac abscesses before and after surgical intervention, often require subcutaneous injections of anticolibacillary serum, and even perisigmoidal and perirectal abscesses. The serum in these affections, is a precious adjuvant for the surgeon. It is also useful to introduce a certain quantity into the field of operation.

Bacteriological study of suppurative salpingitis may demonstrate *Bacillus coli*. In such cases it is also very useful as has been shown by Chevasseu, surgeon of the Cochon Hospital, to introduce the anticolibacillary serum into the field of operation, and to inject the same serum subcutaneously for 2 or 3 days (20 to 40 cubic centimeters per day). Thus one brings about a sharp drop in the fever and prevents an extension of the infection or its general dissemination through the blood stream.

The urinary tract, in woman as well as in man is the seat of predilection of the colon bacillus. Basseler has found *Bacillus coli* in the urine of healthy subjects 18 times in 101 instances. But this observation should be verified. It is the same in the cases of William Esthel who reports no less than 36 per cent of urinary colibacillosis in patients who are affected with constipation or intestinal affections.

In pathological states the bacillus appears in the urine, either primarily or secondarily in surgical affections, of the kidney, ureter, bladder and urethra and colibacilluria is extremely frequent. All maladies of the removal apparatus: lithiasis, hydronephrosis, cystic kidney, benign or malignant tumors, urethral stricture, prostatic hypertrophy etc. all encourage colibacillary localization. In some cases renal tuberculosis is complicated by the same infection and prognosis becomes particularly grave.

Explorations of the bladder and ureters may result in the ensemation of the urinary passages with various bacteria among which *Bacillus coli* is the most common.

These maladies, in which the colon bacillus has developed secondarily, justify above all, surgical treatment, it is upon such treatment that recovery depends. Serotherapy obviously can do nothing in renal or vesical calculus tumors prostatic adenoma urethral stricture etc.

However, in these maladies as long as the determining cause persists and keeps up the local infection serotherapy is an adjuvant to surgical treatment. And even when surgical treatment has already been instituted anti colibacillary serotherapy can be used as a necessary complement to such treatment, in combating the multiplication of the bacilli and against their becoming generalized which is so often a danger.

And so, according to Hunt's statistics 16.5 per cent of patients operated on for hypertrophy of the prostate, die of septicemia. *Bacillus coli* is the common agent in these fatal infections. In the urological services of the Cochin Hospital in Paris the hospital of the Val-de-Grâce, the Hospital of Montpelier, etc., the serum is systematically utilized in this manner and very effectively.

It is customary to recommend also as a prophylaxis anticolibacillary serotherapy in patients who must submit to operation on the urinary tract when they are already infected. The injections of serum (20 cubic centimeters per day) are given on the day before the day of operation, and the following day. It is especially in nephrectomy renal or vesical lithiasis, or in the removal of the prostate that this prophylactic measure is indicated.¹

Primary suppurative colibacillus pyelonephritis,² recent or remote is usually cured in a few days by serotherapy, with or without lavage of the renal pelvis and bladder.

As is well known primary suppurative pyelonephritis is sometimes a complication in

various infectious states grippe, typhoid fever (H. Vincent) malaria (H. Vincent) bacillary or amebic dysentery. They may accompany or follow colon bacillus septicemia. I have shown that in 47.5 per cent of cases patients with primary pyelonephritis of *Bacillus coli* origin have in their history chronic appendicitis with or without operation. Stubborn constipation is a very common cause of colon bacilluria.

The colon bacillus may find lodgment and grow in the kidney when some mechanical obstacle hinders the passage of fecal material in the intestine (compression of the intestine by a tumor by pregnancy chronic enterocolitis intestinal ptosis etc.) It is the same when the passage of the urine is impeded or blocked by compression of the kidney, or the ureter or by renal ptosis.

In all these cases *Bacillus coli* has the intestine as its point of departure. It is moreover, frequently accompanied in the lesions and in the urine by other microorganisms of the same origin enterococcus and staphylococcus above all. I have more rarely found micrococcus tetrages, proteus vulgaris the streptococcus the bacillus of Friedländer, the pseudodiphtheria bacillus, certain anthracoides bacilli a very markedly Gram negative bacillus, certain anaerobes etc.

It is of primary importance, before practicing serotherapy to make a careful cytological and bacteriological study of the urine, and to verify by cultivation on appropriate media (lactose broth neutral red broth, litmus milk various sugars, etc.) the identity of the *Bacillus coli* isolated in the urine. A superficial examination may lead to errors of diagnosis of the micro-organism. According to my experience, in 18 per cent of cases, the urinary infection has been found to be of other organisms than the colon bacillus.

Leaving the intestine the renal infection is followed nearly always, as I have myself shown, by a blood infection, sometimes severe, sometimes light. It gives rise, at times, to extensive histological lesions, especially of multiple areas of suppurative glomerulitis and periglomerulitis, with enormous accumulations of bacilli in these infected foci and in the uniferous tubules.

¹ When patients have already received therapeutic injections of horse serum, it is necessary to desensitize them by one or two preliminary injections of 1 cubic centimeter (or 1/2 centimeter by three injections of 1/3 cubic centimeter) of serum, 2 hours before the principal injection of 20 to 40 cubic centimeters. I advise this even in adult subjects who have never previously been subjected to injections of horse serum.

² Without any of the renal, vesical, or ureteral lesions mentioned in the previous section.

Suppurative pyelonephritis due to *Bacillus coli* is fairly often complicated by cystitis. The urine contains a large number of damaged polynuclear leucocytes, desquamated cells of the renal pelvis, ureters and bladder and red blood cells.

The co-existence in the urine of the enterococcus, the staphylococcus and the micrococcus tetragenes, does not introduce, in my opinion any element of special gravity and places no obstacle to healing with use of anticolibacillary serum. In two patients suffering from old suppurative pyelonephritis following pregnancy the urine showed simultaneously the presence of *Bacillus coli* and the enterococcus. But anticolibacillary serotherapy brought about entire recovery. The enterococcus persisted for several months after the disappearance of the *Bacillus coli* and then it disappeared itself.

Other patients with serious forms of colon bacillus pyelonephritis, with association of the staphylococcus and the tetragenes were similarly completely cured after injections of serum.

The association of the streptococcus is much more serious. It obviously demands the use of mixed serotherapy by anticolibacillary serum and the new antistreptococcic serum.

Thus we see that the anticolibacillary serum has a very marked and very rapid curative effect on all forms of suppurative and primary pyelonephritis whether they be of long standing or recent. Serotherapy has cured infected patients with purulent urine which had existed for from 3 to 5 years, and even 10 years in one case that was reported to me.

It is not my purpose to publish here all these cases. I have taken only one example showing the rapid action of the serum in a very serious case. I have reported many others to the Academy of Medicine of Paris.

Mme. H., 42 years of age, in 1922 following her first pregnancy had subacute febrile enteritis which was probably the first stage of the infection which passed soon into a chronic condition. Her urine became purulent. Pyelonephritis complicated the course of her second pregnancy. The urine was filled with pus, numerous colon bacilli and staphylococci. Nine injections of autovaccine produced no result.

The labor was difficult, hemorrhage being abundant. From this time on her condition became one

of extreme gravity. The urine was highly purulent, and there were febrile attacks, renal pain, continuous phenomena of spasmodic enterocolitis, wasting, extreme anemia and complete adynamia. "The patient," said the physician who was treating her, "led a lamentable existence" (Prof. A. Lippens of Brussels). The condition had resisted all treatment and the most severe regimen. It had continued for 5 years.

In 1928, she was given four subcutaneous injections of 40 cubic centimeters each of anticolibacillary serum. The urine, which up to that time had been a bacterial reservoir and full of pus, became perfectly clear and sterile. "In a few days the patient was transformed. She had not felt so happy for five years (Dr. A. Lippens). All the morbid symptoms—pyuria, renal pain, chronic enterocolitis, fever, prostration, mental depression, etc.—disappeared completely in a few days. Several months afterward I was informed that her condition was still excellent. Her appetite had become normal, she had returned to her former weight "she had the bright and rosy expression of a woman in good health. The sterility of the urine has, since that time, continued. Examples of the same nature are today extremely common.

In a general way I have noted this apparently paradoxical fact that the graver the suppurative colibacillary pyelonephritis whether acute or of long standing and accompanied by very marked general phenomena,—fever symptoms of infection etc.—the more rapid is the recovery under the influence of the serotherapy. A great number of authors (Prof. M. Chevassu, Prof. A. Maisonneuve, Prof. Jeanbrau, Drs. P. Roger Petit, Leonhardt, Minet, Vernal, Trocmé, Dayras and R. Bernheim, Darget, F. Charles, and Nogues, P. Charpy, Grandineau, etc.) have published cases in which they have observed and verified these results.

Pyelonephritis of infants may, as I have already said, be unrecognized because the urine of infants is mixed with the other defects in the napkins. The condition may be marked by fever, diarrhea, vomiting, extreme wasting and rapid death. Bronchopneumonia is sometimes added to this syndrome, already so dangerous. But dealbuminated anti-colibacillary serum injected subcutaneously in doses of 20 cubic centimeters during 5 or 6 days, caused rapid recovery of these little patients.

In adults treated by the serum it is often necessary to give, on the fourth and on the

seventh day of the treatment one or two lavages, first of the diseased renal pelvis a 1 per cent solution of silver nitrate being used, and second of the bladder with a solution of 1:1000 or 1:1500 because the antibodies carried by the serum in massive doses do not always penetrate into the urine. When the kidney is damaged it allows the passage of albumin, and with it antibodies in quantity sufficient to destroy the bacilli in the kidney pelvis and bladder. In these cases the urine becomes sterile about the eighth to the tenth day, and it is not necessary to practice lavage.

The example cited above shows that the serum alone may be sufficient to bring about sterilization of the kidney and of the urine. But antiseptic lavage of the renal pelvis and bladder assures the cure with more certainty because it destroys the residual bacilli which have persisted in these cavities.

Disinfection of the renal pelvis and bladder is not of itself sufficient to cure the patients because it is without action on the renal parenchyma. The majority of the patients whom I have observed were treated by this silver disinfection associated with vaccines, autovaccines, bacteriophages, chemical antiseptics, etc., without any result. One patient aged 28 years who had submitted for 3 years to lavage of the renal pelvis and bladder continued to have very purulent urine. Five injections of serum brought about a complete cure, although the young woman had at the same time a mild degree of hydronephrosis.

The most resistant forms of urinary colibacillosis are those which are not accompanied by the presence of pus in the urine or in which the urine shows only rare polynuclear leucocytes. These are the forms that I have called 'stabilized colibacillosis.' However one may bring about their cure by prolonging the injections of serum for a week or more carrying out, during this period and afterward, the disinfection of the diseased renal

pelvis and bladder repeated two or three times. Anticolibacillary serotherapy is, then, the surest and most efficacious method of treatment of primary suppurative pyelonephritis whether acute or chronic.

Although it acts in all stages, it is preferable to inject the serum early in the pyelonephritis, when the phenomena are most acute; the urine is filled with pus and the fever is high.

It is useless or contra-indicated to associate with it any other chemical or vaccinal treatment. The use of vaccine and autovaccine or even the bacteriophage, has been known to provoke in selected cases the development of more resistant strains of colon bacilli. On the other hand by using other means of treatment one may precipitate almost fatally this very stubborn pathological state that I have called 'stabilized colibacillosis,' which is the most resistant form of infection.

It is desirable to call attention to the necessity in patients recovered from pyelonephritis of remembering that the morbid state which induced the renal infection still persists. After such recovery one should watch the digestive tract and appendix, combat constipation, treat visceral and intestinal ptoses, consider the gall bladder, give advice as to prudent alimentary and general hygiene, and send the patient, after the cure, to the country or if the nervous condition permits for a sea voyage or possibly to certain of the hydro-mineral resorts such as those of La Preste or Capvern in France.

The persistence of the cause which in the first instance determined the invasion of colon bacilli may lead ultimately to a new infection of the kidney after a year or more, in subjects who have recovered bacteriologically.

Consequently a primary infection even when prolonged, of the kidneys by the colon bacillus does not necessarily confer after treatment, immunity of these viscera against a new attack of the same infectious agent.

CLINICAL SURGERY

FROM THE MEMORIAL AND THE FIFTH AVENUE HOSPITALS

THE ORIGINAL JANEWAY GASTROSTOMY

HAYES E. MARTIN M.D. AND WILLIAM L. WATSON M.D. F.A.C.S., NEW YORK, NEW YORK

IN 1913 the late H. H. Janeway published a description of his original technique for gastrostomy. The main principle of the Janeway operation is the construction of a narrow plastic tube from a full thickness flap of stomach wall. This tube leads from the stomach cavity to the skin and furnishes a gastric fistula entirely lined by mucosa rather than by granulation tissue as in most other methods. In his report of 5 cases, Janeway used a left, upper mid rectus incision and led the plastic tube out through the operative wound. He later modified this technique by using a longer midline incision between the xiphoid and the umbilicus and brought the plastic tube out through a stab wound in the middle of the left rectus just below the costal margin. This modification then became the standard technique at Memorial Hospital and was described by Quick and one of us in 1928 at which time we reported a series of 172 cases with a mortality of 18 per cent.

An analysis of the causes of postoperative death in this series revealed that many were due to complications resulting directly from the operative procedure such as infection and subsequent separation of the edges of the midline operative incision. Wound infection is, of course, both a more common and a more serious complication in the debilitated subjects in whom gastrostomy is indicated.

In our efforts to lower this postoperative mortality, we returned again to the original Janeway technique making a short (about 6 centimeter) incision through the middle of the left rectus, just below the costal margin delivering a portion of the anterior wall of the stomach, constructing the plastic tube, and fixing it in the upper angle of the wound. This change in technique has been followed by a remarkable improvement in the postoperative mortality. Since 1928, we have performed gastrostomy by this technique in 52 cases with a mortality of 3 (5.8 per cent). We believe that these 3 postoperative deaths were incidental

or due to the disease (carcinoma of the esophagus) rather than to the operation. The mortality will be discussed further later in this report.

The reasons for this improved mortality with the change in technique are quite readily understood. The body of the stomach or corpus ventriculi from which the plastic tube is to be constructed lies directly under the upper portion of the left rectus muscle and the adjacent costal margin. Therefore a short upper left mid-rectus incision will permit a more direct and an easier access to this portion of the stomach than a much longer midline incision. In the majority of cases, as soon as the peritoneum is opened, the anterior wall of the stomach is seen lying directly in view. With a sponge forceps a sufficient portion is delivered through the wound to permit the entire operative procedure on the stomach to be done outside the abdominal cavity. Since no retractors are required after the stomach is delivered, there is little discomfort and practically no surgical shock. After the construction of the plastic tube, its attachment in the upper angle of the incision and the closure of the operative wound is quickly accomplished in a few minutes. Since the whole procedure is done with a minimum exposure and a minimum manipulation within the abdominal cavity and of the wound edges, infection should seldom occur with good technique. Gastric contents, will, of course sometimes contaminate the wound edges with subsequent wound infection, but in our series never resulted in separation of the fascia and caused no mortality and a very slight morbidity.

The location and behavior of the operative incision is perhaps more important in this operation than in many others. Janeway abandoned the left rectus incision because of too frequent infection and breaking down of the wound with subsequent detachment of the plastic tube from its moorings, a complication which is avoided by keeping the incision short. In an attempt to avoid contamination of the operative wound and to in

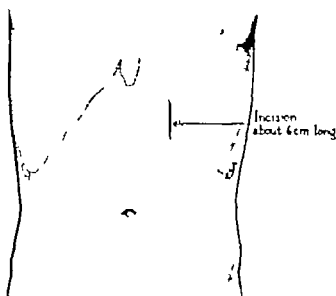


Fig. 1 The operative incision is made through the middle of the left rectus beginning as high as possible at the subcostal margin. It should be kept short. Six centimeters usually is sufficient.

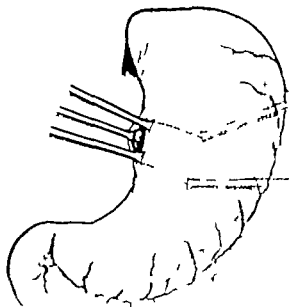


Fig. 2 The first incision is made in the longitudinal diameter near the lesser curvature. An Allis clamp is placed on the lesser curvature side.

sure the fixation of the plastic tube he brought the latter through a separate stab wound. In so doing the operative wound is best made in the midline since a right split rectus incision does not permit of easy access to the body of the stomach without too great length and considerable retraction and manipulation. In any case a midline incision must be at least 8 to 10 centimeters in length or even longer to permit the necessary manipulation for delivery of sufficient stomach and fixation of the plastic tube in a separate stab wound. This midline incision above the umbilicus is we believe the weakest in the entire abdominal wall from the standpoint of immediate healing. It is certainly far simpler to fasten the plastic tube in the operative wound but this is attended by far more danger of wound infection and subsequent serious complications unless the operative wound is kept short and is made through the strongest portion of the abdominal wall (the rectus muscle).

In our previous report, we also advised inserting the feeding tube through the pylorus, so that the feedings would be delivered into the duodenum for the first few days. The purpose of this procedure was to avoid distention of the stomach until healing was firm. With the present technique we insert the feeding tube into the stomach only and have found that our former precautions were entirely unnecessary and necessitated more intragastric and intra-abdominal manipulations

which tended to produce more surgical shock and infection of the operative wound from contamination by gastric and duodenal contents.

Other factors being equal we are convinced that the success of this operation depends upon keeping the operative incision short. In the average case there is not a great thickness of subcutaneous fat and an adequate portion of stomach can be delivered through an incision 6 centimeters in length. Such a wound does not require a great deal of separation of muscle fibers and is closed by 3 or 4 sutures. There is little lateral tension on

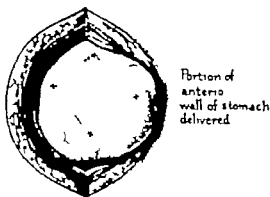
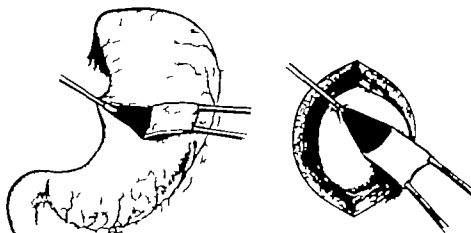


Fig. 3 A portion of the anterior wall of the stomach is delivered through the 6 centimeter incision. The dotted lines show the position and relative size of the intended flap.



Figs. 4 and 4A. The flap has been raised and the Allis clamp at the lesser curvature marks the point of beginning closure.

the wound edges and even though there is slight infection the fascial edges never separate and permit dislodgment and withdrawal of the plastic tube within the abdominal cavity.

INDICATIONS

Gastrostomy is indicated in all cases of persistent dysphagia in which complete relief cannot be expected within a reasonably short time. In dysphagia of benign origin such as peptic ulcer of the esophagus, syphilis, tuberculosis, or in burns following the swallowing of caustics the indications are too clear to require any special comment. Cardiospasm is almost always amenable to dilatation alone.

Practically all the controversy concerning the indications for gastrostomy is in carcinoma of the esophagus. We believe gastrostomy to be the best palliative treatment for dysphagia due to malignant stricture of the esophagus, hypopharynx or cardia and that this operation is attended by less risk, discomfort, and mental anxiety than is either bouginage or intubation. We also believe the average length of life to be greater in unselected cases. Bouginage is indicated in patients refusing operation, especially in malignant strictures of the upper half of the esophagus where the arrested ingesta do not ordinarily cause marked distention or sacculatation of the esophagus.

Gastrostomy puts the malignant stricture at rest and promptly overcomes malnutrition. No further painful or distressing manipulations are required to insure the continuation of proper alimentation. In both bouginage and intubation the

traumatic procedures which surely hasten the extension of the disease must be repeated every few weeks as long as the patient survives.

Those who favor bouginage or intubation emphasize the disadvantages of gastrostomy such as the operative risk, leakage from the stoma, and the discomfort of constantly wearing the feeding tube. These objections are perfectly valid in operations of the Witzel type but in the Janeway operation as herein reported, these objections have little or no comparative importance.

We have had no personal experiences with intubation but have used bouginage in so cases. The latter procedure is not possible in all instances, depending on the location of the stricture and its morbid anatomy. It is furthermore both distressing and painful in the majority and must be repeated at regular intervals. The same objections apply equally to intubation. In practically all cases in which we have used bouginage there comes a time after a few weeks or months when this procedure becomes so difficult or is accompanied by so much pain or bleeding that it must be discontinued or done at the risk of immediately fatal consequences. In such cases one is forced to witness death by dehydration or starvation since gastrostomy at this stage is a futile gesture.

If gastrostomy is to be done in cancer of the esophagus, the earlier the operation is performed the better. It should never be deferred until there is marked loss of weight and strength. If the patient is still able to swallow liquids, he may defer using the stoma for feeding purposes for a time. Its presence causes no discomfort. If length of life is the only consideration nothing but water

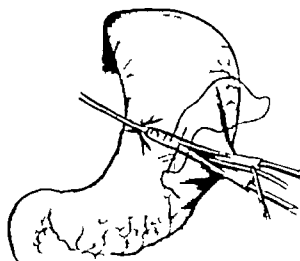


Fig 5 The feeding tube has been inserted into the stomach. Partial closure of the mucosal layer has been effected.

should be taken by mouth after operation since a portion of swallowed food almost always remains above the stricture to ferment and decompose.

The technique is clearly outlined we believe in the accompanying illustrations and will therefore be quite briefly described. If there is even moderate dehydration the operation had best be deferred for 24 to 48 hours so that the lost fluids may be made up by several hypodermoclyses and by rectal administration. Local anesthesia is to be preferred. Many patients requiring gastrostomy are in such a state of inanition that general anesthesia is inadvisable. The operative procedure and intra-abdominal manipulation is so limited that it is seldom that the patient complains of much discomfort.

TECHNIQUE

Under local infiltration alone or combined with a subcostal block, an incision 6 centimeters in length is made through the middle of the left rectus beginning as high as possible at the subcostal margin (Fig. 1). Behind the rectus muscle at this point lie fibers of the transversalis muscle. These are either separated and retracted or partly cut through. A sphincteric action of these muscles was formerly emphasized but we question if it is of much importance in maintaining continence.

When the abdominal cavity is entered the anterior wall of the body of the stomach is usually seen lying directly under the wound. In some cases the stomach may be situated high or the costal margin unusually low and slow manipulation is necessary to stretch the gastrohepatic omentum sufficiently to allow partial delivery of the stomach. It is well to pull the stomach a little

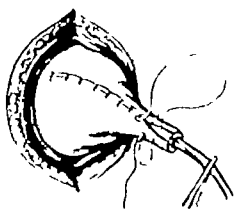


Fig 6 The mucosal suture has been completed. The serosal suture is partially completed. Note the clamp fixing the feeding tube to the end of the mucosal suture.

to the right so that the plastic tube is placed as far toward the cardia as possible without too much tension. Care should be taken that the plastic tube is constructed from the body of the stomach rather than from the pyloric antrum. In the latter case, leakage and discomfort after feeding are more common. A portion of the anterior wall near the lesser curvature about 8 centimeters in diameter is then delivered through the wound (Fig. 2) and packed about with wet lap sponges.

A rectangular flap about 3 centimeters long and $2\frac{1}{2}$ centimeters wide with its base toward the greater curvature and its free end at the lesser curvature is then outlined by Allis clamps (Figs. 2 and 3). The stomach wall is always contracted particularly in the transverse diameter when delivered and the flap will be found to stretch markedly and become 4 to 5 centimeters in length as the plastic tube is constructed.

The first incision should be made at the free end of the intended flap and parallel to the lesser curvature and as the stomach is entered an additional Allis clamp should be placed in the center of this incision on the lesser curvature side to mark the point of beginning closure (Fig. 3). From the extremities of this incision two others are made at right angles toward the respective clamps which mark the base of the flap (Figs. 3 and 4). As the flap is freed the two Allis clamps which mark its tip should be removed and replaced so as to grasp all coats of the stomach wall.

After the ligation of bleeders a No. 14 French catheter is placed within the stomach only and closure is begun at the clamp which marks the middle of the first incision at the lesser curvature continuing up the edges of the flap to form a gooseneck tube. We use an interlocked layer of No. 00 chromic to the mucosa and muscular

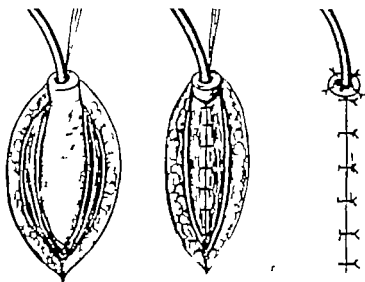


Fig. 7. Showing successive stages of fixation of the plastic tube and closure of the abdominal wound.

coats, and an interlocked Lembert suture of the same material to the serosa (Figs. 5 and 6). When these sutures are completed to the apex of the plastic tube, they are cut long and clamped so as to secure the gooseneck until it is sutured in place. The delivered portion of stomach is then returned to the abdominal cavity and the plastic tube is placed in the upper angle of the wound (Fig. 7). Closure of the abdominal wound is accomplished in the usual manner not too tightly about the tube which is attached to the external rectus fascia by two stitches of No. 0 chromic through the serosa only. The plastic tube should protrude slightly above the skin surface (Figs. 8 and 9). It is sutured to the skin by 4 sutures of silk. A vaseline dressing is applied about the catheter which is made to protrude through all layers of the dressing and adhesive so that the feedings may be given without removal of the dressings.

POSTOPERATIVE CARE

As soon as the patient is returned to the ward he is given 3 ounces of water through the feeding tube. Following this he is given 3 ounces of milk every 2 hours until the morning after operation when the amount is increased to 4 ounces every 2 hours. The following day 5 ounces every 2 hours and so on, increasing the amount of the feeding to 16 ounces. When the feedings have been increased to about 10 ounces, the interval is lengthened to 3 hours and later to every 4 hours, and finally all feedings are omitted during the nightly

period of rest. The caloric value of the feedings is increased by the addition of lactose eggs, and butter added on successive days beginning about the fifth or sixth day. Orange juice or tomato juice should be added about the same time.

The reason for beginning with small frequent feedings of plain milk is not because of fear of distention of the stomach but rather to avoid gastro-intestinal disturbances which may occur with too copious feedings in patients whose digestive tracts have become unused to digestion. An uncommon postoperative complication is diarrhoea, which may be fatal the gastro-intestinal tract apparently being unable to retain even fluids. In such cases, the feedings must immediately be reduced to the original quantity (3 ounces) of boiled milk with the addition of small doses of tincture of opium.

The patient may be safely allowed out of bed with a firm abdominal binder on the third to the fifth day depending chiefly on the pre-operative condition. The position and shortness of the operative incision are such that there is no danger of too early a strain on the incision.

When the skin sutures are removed the feeding tube is withdrawn and inserted only for feeding purposes. Until the nursing staff is familiar with the after-care of this operation it is safer to leave the feeding tube in place constantly the surgeon himself changing it every day or two until about 2 weeks after operation. Inexperienced attendants may misdirect the tube outside the tract and

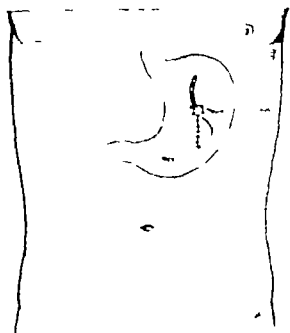


Fig. 8. The completed operation showing the relative position of the operative incision, the stomach and the plastic tube.

force the feeding into the peritoneal cavity. After firm healing, there is no danger of this accident. There is no danger of closure of the stoma even if the tube be left out for months. In no case should a larger feeding tube than a No. 16 French catheter be used. Since all feedings must be liquid in any form of gastrostomy, there is no advantage whatever in a larger tube which will only tend to cause leakage by stretching the stoma. At the completion of a feeding when the tube is with drawn, firm pressure with a gauze sponge over the stoma for a minute, allows the fistula to contract and continence is usually entirely satisfactory and a single gauze sponge is sufficient to cover the stoma under the clothing.

While in the hospital the patient should be taught to insert the tube and feed himself. The caloric value of the daily feedings should be at least 3,000 calories, including the necessary vitamins. Many intelligent patients seem to derive a great deal of interest in the make up and calculation of the feedings. For the guidance of the average patient we furnish a mimeographed copy of the following instructions.

POSTOPERATIVE MORTALITY

In our series of 52 gastrostomies done by the present technique there have been 3 postoperative deaths (5.8 per cent), which we believe to have been incidental and due to the disease (carcinoma

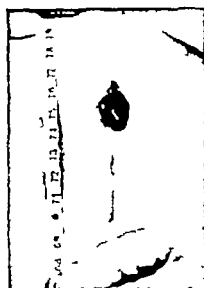


Fig. 9. Healed condition after operation. Note that a small portion of gastric mucosa protrudes above the skin surface.

GASTROSTOMY FEEDING

Patient's name	Address			
Hours of feeding	Milk	Milk sugar	E (ster. melted)	Fresh eggs (raw)
6 a.m.	2 1/4 cups or 17 oz.	3 scant tbsp.	1 t. p.	
8 a.m.	(8 oz. from 1 pice)			
10 a.m.	17 oz.	3 scant tbsp.	1 1/2 tsp.	1
2 p.m.	7 oz.	3 scant tbsp.	1 1/2 tsp.	1
6 p.m.	17 oz.	3 scant tbsp.	3/4 tsp.	1
10 p.m.	17 oz.	3 scant tbsp.	1 1/2 tsp.	1

At 1 a.m. 1 dram (1 tsp.) iron and ammonium citrate

1. Insert tube only for feedings.
2. Make up each feeding fresh. Heat slightly before using.
3. Take feeding slowly—allow at least 10 minutes for each feeding.
4. Rest 10 minutes after each feeding.
5. Clean feeding tube with water after each feeding—do not boil.
6. Obtain from drug store:
 1. One No. 14 French catheter.
 2. "Asepto" syringe with a tip to fit catheter.
 3. Large can of Lactose (milk sugar).
 4. Iron and ammonium citrate, ounces 8, and take 1 teaspoonful in the 10 a.m. feeding.
 5. One 8 ounce measuring cup.
7. If constipated take one ounce of castor oil in the last feeding at night.
8. Take nothing by mouth except water. This may be taken in small amounts if it does not cause vomiting.
9. If stomach distress and nausea follow the feedings, the milk content should be reduced to 12 ounces for 2 or 3 feedings.
10. Any unusual symptoms or difficulties should be reported to the hospital.

of the *oesophagus*) rather than to complications resulting from the operative procedure. One patient had an uneventful recovery with primary healing until the ninth postoperative day when he suddenly fell dead while walking about the ward in apparently good condition—probably a cardiac death. The second was admitted with complete dysphagia and symptoms of mediastinitis. X-ray examination showed the presence of a broncho-*oesophageal* fistula and bronchopneumonia. After 48 hours during which time fluids were forced by hypodermoclysis and proctoclysis, his condition improved sufficiently so that gastrostomy was thought indicated since the patient could swallow not even water. The postoperative course was fairly satisfactory for 12 days. He died on the fourteenth postoperative day and autopsy showed death to have been due to broncho-*oesophageal* fistula and bronchopneumonia. A third patient died on the fourth postoperative day from *oesophageal* hemorrhage probably from perforation of the aorta by disease.

Carcinoma of the *oesophagus* is a lethal disease and gastrostomy is not done in many cases until such terminal complications as perforation of the growth into a large vessel or bronchus are imminent. Such complications are apt to occur during the postoperative period and therefore gastrostomy if done for cancer of the *oesophagus*, will always be followed by a certain unavoidable per-

centage of postoperative deaths. Good statistics will, therefore, depend partly on chance and on as early operation as is possible.

The postoperative mortality in gastrostomy varies from 6 to 20 per cent as published by various authors. We believe that the lower figure is possible with the Janeway technique and the advocacy of operation as soon as the diagnosis is made.

SUMMARY

The advantages and technique of an improved original Janeway gastrostomy are described. This operation differs from that already published by Quirk and one of us, in that the procedure is done through a single 6 centimeter incision through the middle of the left rectus just below the costal margin. The fistulous tract from the stomach to the skin is formed by a plastic tube constructed from stomach wall. By this technique we have performed gastrostomy in 52 cases with a postoperative mortality of 5.8 per cent.

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FROM THE CLINIC OF DR. PHILIP LEWIN, MICHAEL REESE HOSPITAL

THE GALEAZZI TREATMENT OF SCOLIOSIS

PHILIP LEWIN, M.D., F.A.C.S., CHICAGO

SCOLIOSIS is one of the oldest conditions described in medical literature. Hippocrates gave the generic term "scoliosis" to any twisted spine. An extensive literature much of which is repetition has been accumulated on the subject. The outstanding contributions have been made by such men as Schulthess, Wullstein, Lovett, Brackett, Abbott, Freiberg, Kleinberg, Hibbs, Steindler, Feiss, Calve, Buchman, Brewster, Risser, and Galeazzi.

The spine, a flexible weight-bearing column made of segments and already curved in one plane (anteroposterior) will not yield in another plane (lateral) without twisting. In this twist the vertebrae must turn away from the greatest weight and pressure, that is toward the convexity.

The etiology of scoliosis involves chiefly such factors as (1) heredity, (2) congenital anomalies of the spine, (3) pathological conditions of the vertebrae, (4) nutritional changes, (5) infections, (6) epiphyseal changes, (7) muscle disbalance, and (8) paralytic conditions. There is a large group of cases included under the term "idiopathic scoliosis."

Hibbs believed that in a great many more cases than were recognized the condition was due to infantile paralysis. Buchman believes that many are due to vertebral epiphysitis. Jansen attaches importance to irregularities in the attachments of the diaphragm.

Ferguson has been impressed by the apparently reciprocal relation between rotation and wedging of the vertebral body. With a curve of given degree in a given area of the spine he finds a definite amount of rotation unless wedging is present. With wedging there will be less rotation. Wedging appears to decrease the need for rotation.

In 1844 Bigelow advanced the principle that torsion rotation is illustrated by bending a blade of grass or a flat flexible stick in the direction of its width. The center rotates on its longitudinal axis to bend flatwise in the direction of its thickness. Likewise the spine laterally flexed turns on its vertical axis, to yield in its shortest, or anteroposterior diameter. This statement according to Smith implies (1) that there is a continuity of substance in the spine, (2) that the

spine is flat, (3) that the plane of flatness is in the frontal plane, and (4) that rotation is a concomitant element of lateral flexion.

When he began his investigations of the subject of scoliosis, Carey found that there was very little accurate anatomical and physiological knowledge concerning the mechanism of production of structural scoliosis. By two types of experimentation and investigation he has been able to make some interesting and important observations on the subject. The first method included a series of experimental amputations, selective muscle and nerve excisions, tail fixations, undernutrition experiments in young animals, and observations on the dynamics of the histogenesis of muscles, bones, and joints. The second method was the construction of a working model of the anatomical and physiological relations of muscle and bone levers of the normal human back. By this means results of experimental muscular imbalance registered at once on his spinal indicator, whereas by animal experiments he was forced to wait months and sometimes over a year for the same change to occur. This model is a most ingenious piece of mechanical construction. It enables one to demonstrate the greatest variety of structural mechanical changes and to visualize the normal and

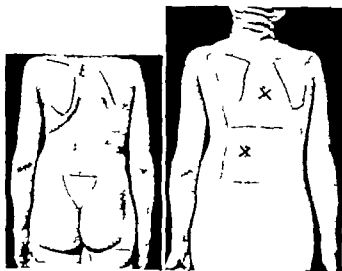


Fig. 1. Left. Skin marks.

Fig. 2. Stockinette with marks indicating spinous processes and acromioclavicular joints. 'X' and 'V' mark centers of thoracic and lumbar curves.

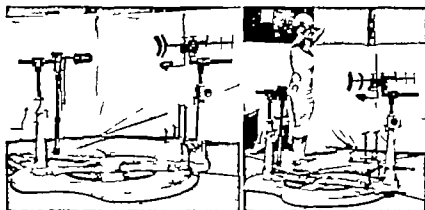


Fig. 3 Galeazzi apparatus showing two end fixation mechanisms for immobilizing pelvic and shoulder girdles and two floor nuts. (Under worm gear apparatus not shown.)

Fig. 4 Patient standing on platform preparatory to fixation of pelvic and shoulder girdles. Note outline of great trochanter and crest of ilium.

abnormal dynamic equilibrium of the musculature of the body as a whole.

Carey believes that imbalanced action of bilateral antagonistic musculature resulting from undernutrition or malnutrition during the first decade of life will explain many cases of idiopathic scoliosis. He found that there are numerous possible combinations of muscular imbalance. With only 13 pairs of spinal muscles there are more than 67 million possible combinations of muscular imbalance resolved by the mathematical formula (2^I) . There are 144 muscles directly attached to the movable spine. It is impossible

to conceive the results of multiplying out to the 144th power.

When I told Dr. Steindler in 1915 that I was going to Europe, he advised me to visit Galeazzi at Milan. At Manchester, England, I met Platt who spoke very favorably of the method. Then Delitala of Venice recommended it. In 1919 I visited Galeazzi again. In May 1931 I made my third trip. In 1928 I demonstrated the method before The Clinical Orthopedic Society in Chicago.

Through the efforts of Dr. D. H. Levinthal, the Ruth Lodge of Chicago purchased the apparatus

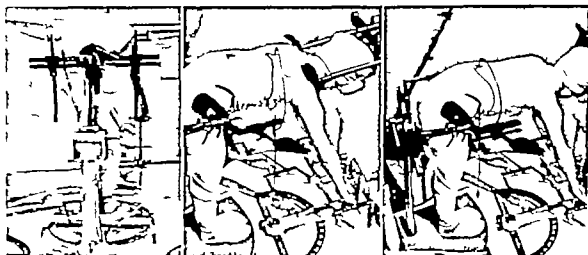


Fig. 5.

Fig. 6.

Fig. 5. Rear view of patient in apparatus with pelvic girdle fixation.

Fig. 6. "Centering" of thoracic and lumbar curves over mts on floor of apparatus by means of plumb.



Fig. 7. Rear view showing deflexion of lower back



Fig. 8. Sheet wadding applied to pelvic and shoulder girdles.



Fig. 9. Application of pelvic and shoulder plaster girdles.

at a cost of one thousand dollars and presented it in 1930 to Michael Reese Hospital. I began using the apparatus in September 1930. Dr. Levinthal and I have worked with the machine individually and together.

I wish to outline the general considerations of a method of treating the difficult problem of scoliosis which has been found to be highly successful in the originator's hands. This is a preliminary report based upon observation in Galeazzi's clinic in Milan in 1925, 1929 and 1931 and in my own clinic.

The method may be described as follows. The patient is placed under an intensive preparatory

mobilizing treatment for a long period varying with the degree of rigidity of the spine. Special apparatus and exercises are used in this preparatory treatment. Accurate tracings are made by the Schulthess method as well as plaster-of-Paris shells and models. Then one proceeds to correct the deformity by means of the apparatus herewith illustrated. There are two independent units, one which secures the shoulder girdle and the other the pelvic girdle. The patient is placed on a raised platform within the apparatus, with the trunk horizontal and hips and arms flexed so that the spinal column is suspended from two end buttresses; that is, he assumes the position



Fig. 10. Pelvic and shoulder girdles complete. Ready for deflexion and derotation.



Fig. 11. Lower back deflexed and derotated.



Fig. 12. Cast almost complete, showing traction bands still in situ.

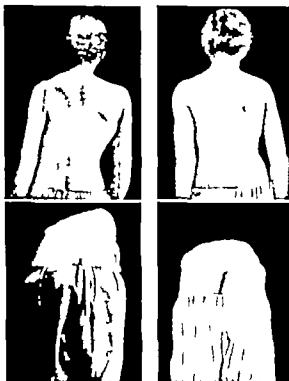


Fig. 13. A patient with right structural scoliosis corrected in Galeazzi apparatus (Courtesy of Professor Galeazzi.)

of a quadruped. By varying the distance between the two end units and their relative heights above the ground, it is possible to place the spine in the most favorable position for correction. When this position has been obtained, the two end units are secured, so that the apices of the thoracic and lumbar curves correspond with the centers of the rotatory mechanism which are indicated by two nuts on the floor of the apparatus. A plumb line is used for this purpose.

The apparatus permits independent rotatory movement of the two end units around a vertical axis, which accomplishes lateral deflexion of the spine. It also allows rotatory movements around the longitudinal axis of the spine producing derotation and detorsion.

The scoliotic spinal column is secured at its two ends by the application of two plaster-of-paris sections, including the pelvic and shoulder girdles. By means of a three tailed bandage applied over the apex of each curve and held by an assistant so as to act as fulcrums, one slowly begins to correct by means of deflexion and derotation against the fixed shoulder and pelvic girdle sections. These are then united by the third plaster-of-paris

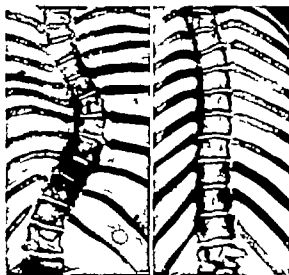


Fig. 14. Roentgenograms of patient with right structural scoliosis corrected in Galeazzi apparatus. See Figure 13. (Courtesy of Professor Galeazzi.)

section. The principle is analogous to the correction of a club foot by the application of three plaster cuffs.

The cast extends from points high on the shoulders to others below the greater trochanters. Windows are cut out over the concavities of the curves. When the cast is complete, the patient stands in a flexed position and walks with his body flexed toward the convexity in a manner similar to but not quite so severe as in the Abbott method. These casts are changed every 3 months. The total duration of the cast period is from 18 to 36 months.

The chief virtues of the treatment are in correction by deflexion and derotation rather than by means of direct force. The key to the correctability of the spine lies in a long preparatory mobilizing treatment. Galeazzi uses a mobilizer similar to the apparatus used for correction.

Galeazzi has obtained correction even in cases of rigid structural scoliosis. He has used this method in the treatment of several hundred severe, rigid cases of scoliosis with excellent results, as demonstrated by roentgenograms which have disclosed definite, and he believes, permanent correction of the vertebral torsion. He uses celluloid jackets to maintain correction.

It is not my purpose to compare various methods of treatment of scoliosis. I merely wish to describe one method. I have used the Abbott method under Ridlon, Porter and Calot. I have used the original Hibbs traction method. I

have had a limited but very favorable experience with the Risser method which probably is the best in America or possibly the world today. It has the advantage that it is simple and not expensive.

I have made some modifications in the technique since it was described in an article which Galeazzi wrote at my request and which appeared in the *Journal of Bone and Joint Surgery* for January, 1929.

The disadvantages of the method include (1) the cost of the apparatus (2) the long period of preparation by means of special apparatus necessary to accomplish good results (3) the difficult technique of application and (4) the long after treatment.

The illustrations were made at the same time a moving picture film was prepared to illustrate

Galeazzi's method. The subject was a patient of Dr. Levinthal.

SUMMARY

After an intensive preparatory mobilization period the patient is placed on a small elevated platform and the pelvis is secured firmly. He bends at the hips and shoulders with hands supported on uprights and forehead on a rest i. e. he assumes the position of a quadruped. His pelvic and shoulder girdles are secured by sections of plaster of Paris. His torso is then deflexed and derotated. The two sections are united by a third.

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OLD TRAUMATIC DISLOCATION OF THE HIP

WITH SPECIAL REFERENCE TO THE OPERATIVE TREATMENT

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SIXTEEN cases of old traumatic dislocation of the hip have been treated at the Peiping Union Medical College during the past 10 years. The time of postoperative observation has extended from 6 months to 9 years, with an average of 2 years for all cases. Since this condition is seen rarely in most clinics, a review of the subject and a presentation of cases seems appropriate.

PATHOLOGICAL ANATOMY

In order to understand fully the pathological anatomy of old dislocations of the hip (Fig. 1) it is necessary to discuss the changes which occur during as well as after the original trauma.

Posterior dislocations. The position most favorable for the posterior type of dislocation is one of flexion, adduction, and internal rotation. Ordinarily the capsule is torn through in the postero-inferior portion. As the head of the femur passes backward and upward it may tear one or more of the small rotator muscles. The quadratus femoris lies directly in the path of the head during dislocation; hence it is injured very frequently. The obturator externus, obturator internus, the gemelli, and even the pyriformis may be injured similarly in severe cases. Occasionally the head may push its way between the obturator internus and the pyriformis, or between the pyriformis and gluteus minimus, without trauma to these muscles. If the dislocation occurs below the tendon of the obturator internus, the head then passes laterally and upward so that the tendon lies between the neck of the femur and the ilium (dislocation below the tendon—Bigelow—Fig. 2). In the same way the tendon of the pyriformis may be wound around medial to the neck of the femur (Fig. 3). An intact condition of the Y ligament is responsible for producing the characteristic position of the thigh after dislocation, i.e., flexion, adduction, and internal rotation. In rare instances the Y ligament may be ruptured completely with the result that the thigh is then held in a position of flexion, abduction and external rotation—the so called everted posterior dislocation.

Contractures of the pelvic femoral muscles soon take place in the untreated case. As time goes on a new capsule of scar tissue forms around the head of the femur fastening it securely to the side of the

pelvis. Within 4 weeks time ligamentous shreds, fat, and new connective tissue fill the acetabulum. This mass of tissue adheres firmly to the cartilage so that, after 6 weeks, sharp dissection is necessary for its removal. As early as 1893 Volkmann recognized these changes following experimental dislocations in rabbits and dogs. He found that after 3½ weeks new connective tissue adhered firmly to the cartilage and that after 8 or 10 weeks the joint was filled with a hard fibrous mass which in itself prevented reduction. One of the writers (L. J. M.) repeated these experiments with essentially the same findings.¹ Similar clinical observations have been made by surgeons during the operative treatment of congenital dislocations. In several instances redilatation of the hip occurred shortly after open reduction and, upon re-operation 3 to 4 weeks later the acetabula were filled completely with adherent soft tissues.

Changes in the head of the femur occur almost routinely as a result of the original trauma or the pressure forces which follow dislocation (Fig. 4A). If a piece of the femoral head has been crushed or broken off during the dislocation the late findings are those of roughening and partial disappearance of the cartilage—changes simulating advanced arthritis. In the very old cases, the head may be flattened or roughened because of weight bearing in a deformed position.

Anterior dislocations. In the anterior group of dislocations, displacement of the head of the femur most commonly is against the obturator foramen, with abduction, external rotation, moderate flexion, and apparent lengthening of the thigh. The head of the bone tears through the capsule in the antero-inferior portion and lies on the obturator membrane where it is partly surrounded by the torn fibers of the obturator externus muscle. The ligamentum teres may be stretched or completely torn through. The small external rotator muscles of the hip are drawn over the posterior edge of the acetabulum. In all old anterior dislocations whether obturator, pubic, or perineal in type, the acetabulum fills with a mass of scar tissue just as it does in the posterior variety. Complete tearing of the Y ligament also is very unusual in the anterior type. In late dis-

¹Unpublished work.

locations of either anterior or posterior type an unusual amount of new bone may form around the displaced head (Fig. 4B).

OPERATIVE TREATMENT

Preliminary skeletal traction In late posterior dislocations traction as a preliminary step before reduction by either the closed or open methods is a procedure which cannot be overemphasized. By this means the contracted structures are stretched gradually until the head of the femur has been pulled down to the level of the acetabulum (Figs. 5A and 5B). As a result the amount of force necessary to effect reduction and the local trauma produced at the time of operation becomes much less. In cases of more than 1 month's duration the writers advocate skeletal traction with a Steinmann pin through the lower end of the femur. (For technique see Case 1.)

Closed reduction Most traumatic dislocations of the hip may be replaced by the closed method if the duration is less than 4 weeks. Following this period of time the difficulties of reduction gradually increase so that, after 2 months forceful maneuvers are apt to cause fractures of the upper portion of the femur. Consequently, if closed reduction is attempted between the fourth and eighth weeks it must be performed with great caution and, if unsuccessful, open arthrotomy should be employed. Careful study of stereoscopic roentgenograms will help to determine the advisability of late manipulation. Such study is important since the original trauma may have caused crushing injuries to the head of the femur and any great external force will only effect more damage. A description of the standard technique of closed reduction is not within the scope of this paper.

Open reduction Studies by Bigelow, Malgaigne, Allis, and others of the pathological anatomy of dislocations of the hip led surgeons to a knowledge of the possibilities of open operation. The first arthrotomy to effect reduction of an old traumatic dislocation is usually accredited to Polaillon (1882). Since that time successful operations have been surprisingly few, both because of the rarity of the condition and because of the technical difficulties involved. Buchanan collected from the literature, up to 1920, 49 cases reduced successfully by arthrotomy and added one of his own. The largest individual series belongs to Dollinger (3) who in 1925 reported results obtained by arthrotomy in 29 cases of inveterate traumatic luxations. In his group twenty-one hips were replaced completely. Difficulties in reduction necessitated resection of the femoral head in 7 cases and osteotomy in 1 case.

Two methods of approach have been used for old posterior dislocations, namely, the posterior one of Langenbeck and Hoffa and the anterior one of Smith-Petersen. Dollinger prefers the posterior method which is thus briefly described: An incision is made from the postero-inferior spine of the ilium to the base of the greater trochanter or on down to the insertion of the gluteus maximus. The fibers of the gluteus maximus muscle are split longitudinally, exposing the secondary capsule which surrounds the head of the femur and holds it to the pelvis. The secondary capsule is opened and by forceful internal rotation the head and neck of the femur are swung anteriorly and away from the acetabulum. In the ordinary dorsal dislocation the scarred obturator internus gemelli and pyramidal muscles are now exposed. These muscles may lie between the neck of the femur and the pelvis and stretch across the upper and outer aspect of the acetabulum. Myotomy of these muscles is usually necessary to give full access to the socket of the hip joint. After the removal of all of the scar tissue from the acetabulum, the head of the femur is replaced by circumduction and traction.

Dollinger also uses the same approach for anterior dislocations (obturator) of the hip. In this type access to the acetabulum is blocked by the greater trochanter and the muscles already mentioned; consequently resection of scar tissue, myotomy, and inward rotation of the femur are necessary.

The anterior route was used in all except one of the cases reported in this paper. The incision is started at the middle of the iliac crest, continued forward until the anterosuperior spine is reached and extended downward along the anterior border of the tensor fasciae to below the level of the symphysis pubis. After the periosteal origins of the gluteus minimus and part of the gluteus medius have been stripped loose the upper edge of the acetabulum comes to view. Further dissection is made between the sartorius and tensor fasciae until the rectus femoris and iliopsoas muscles are seen. Myotomy of these muscles and resection of scar tissue allow complete exposure of the socket. The safest approach to the head is made by subperiosteal dissection along the upper end of the shaft and the neck until the secondary capsule is opened widely. The thigh is now rotated externally, causing the head of the femur to point laterally. This tightens the scar tissue which stretches between the neck of the femur and the pelvis. These cicatricial bands are severed transversely. Reduction of the hip may be accomplished by traction and manipulation.

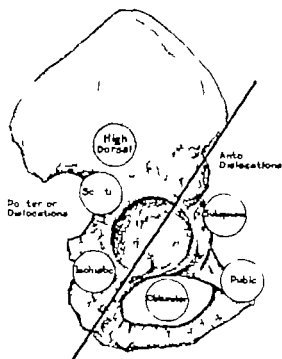


Fig. 1. Schematic drawing which illustrates the various positions of the head of the femur in dislocations of the hip. According to Albee classification a line drawn from the anterosuperior spine of the ilium through the center of the acetabulum divides such dislocations into two main groups. All anterior to this line are designated as anterior dislocations (obturator, pubic, subpubic, and perineal) and all posterior to this line are designated as posterior dislocations (ischiatric, sciatic, and high dorsal). (Redrawn from Wilson and Cochrane.)

For obturator dislocations the anterior or if occasion demands, the combined anterior and median approaches offer good exposure. Recently the writers used a modification of the anterior approach for an obturator dislocation of 3 years duration (Fig. 6). The incision was started at the junction of the anterior and medial thirds of the crest of the ilium, continued forward to the anterosuperior spine and then extended downward along the medial edge of the sartorius muscle to the apex of Scarpa's triangle. The gluteus minimus, rectus femoris, and sartorius muscles were retracted laterally. This allowed ready access to the acetabulum. The scar tissue was removed from the socket following which the upper edge of the head of the femur was exposed. It was necessary to chisel away a shelf of new bone which had formed at the junction of the obturator foramen and the acetabulum. Further dissection allowed exposure of the capsule of scar tissue which surrounded the neck. This was cut trans-

versely. Forceful adduction and external rotation brought the head into full view. Following its long period of contact with the margins of the obturator foramen the head had become somewhat pear-shaped and roughened with hypertrophic flanges of bone at the junction with the neck. Since the acetabulum also was roughened it was believed that if the head were returned to the socket in this condition an arthritic hip joint would result. In the hope of overcoming this almost inevitable sequela the head was chiseled down to one-third its former size and then maneuvered into the acetabulum. In a case of 3 months duration Dr. Steindler used both the median and anterior approaches. The median incision (Ludloff) was made along the inner border of the adductor magnus. The head was approached by dissection between the adductor longus and adductor magnus muscles. Myotomy of these muscles was necessary to allow good exposure of the scarred mass surrounding the head. The secondary capsule was split and the thigh was abducted and externally rotated, making the whole head and neck visible. Exposure of the acetabulum by this route was extremely difficult. A second approach, which was that of Smith-Petersen, was then made. The scar tissue was removed from the socket and the hip was manipulated into normal position.

While complete reduction by open arthrotomy is the goal sought in all cases of old dislocation the surgeon may be forced to accept certain alternative procedures such as the "shelving" operation, resection of bone, arthrodesis, or in exceptional instances, he may be content with simple osteotomy to correct the deformity.

"Shelving" operation (Koenig, 1891; Albee, 1915). The shelving operation consists in the formation of an efficient bony roof over the displaced head of the femur. The shelf is made by turning down plates of bone from the outer surface of the ilium for the purpose of affording stability and preventing pain. Henderson reported a case in which during arthrotomy it was impossible to bring the head of the femur far enough forward and downward to replace it in the acetabulum. Hence with a Murphy reamer such as is used for arthroplasty a new acetabulum was made a little higher than the old one. In addition flaps of bone were turned down over the superior surface of the head. Four months later roentgenograms showed an excellent new acetabulum with a well formed shelf. Motion was fair with flexion 140-150 degrees. He expected a stable hip as an end-result. Shortening in this case was about 3 centimeters previous to operation. It had been 3 centimeters.

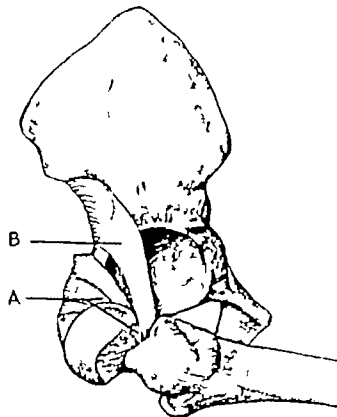


Fig. 2. Sketch illustrating the mechanism of posterior dislocation below the tendon of the obturator internus. The femur is in a position of flexion, internal rotation and adduction. In this type the head of the femur breaks through the posterior inferior portion of the capsule below the tendon of the obturator internus. Note that the head in rotating upward passes lateral to this tendon. The head may also pass lateral to the tendon of the pyramidalis, B. In this event both tendons, A and B, are wound around the neck of the femur and therefore lie between the neck of the femur and the ilium.

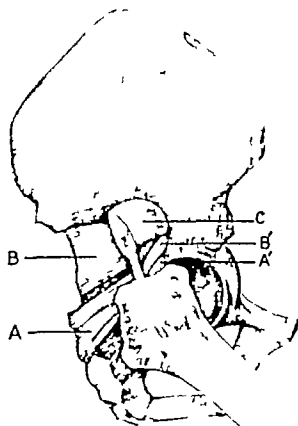


Fig. 3. Drawing to represent a further stage of dislocation into the high dorsal position. Part of the head and neck of the femur (C) has been cut away so that a better view of the tendons may be obtained. The obturator internus, I and I' and pyriformis tendons, B and B' pass between the neck of the femur and the pelvis, and wind anteriorly around the neck to reach their insertions into the region of the great trochanter.

Resection (Hoffa) Dollinger believes that resection of a portion of the head of the femur or even of the whole head, neck and great trochanter may be done if reduction is extremely difficult, or if pressure symptoms are present in the distribution of the sciatic nerve. Following this procedure the upper end of the femur is placed in the acetabulum and partial fibrous ankylosis with good position of the hip is the usual result.

Fusion Arthrodesis of the hip may be the operation of choice in very late cases especially when the musculature is atrophic and contracted. It may also be indicated in cases showing a large amount of new bone at the site of displacement. This procedure should result in a permanent relief from pain, deformity and instability of the hip.

Osteotomy Simple osteotomy for the correction of deformity may be advisable in patients who are old or weakened and who would be unable to withstand the rigors of a more severe operation. Again osteotomy may find an indication in those

cases wherein roentgenograms show that complete reduction would be technically impossible. Figure 4 shows a case of 1 year's duration in which an unusual amount of bone had formed in the torn soft tissues. In this instance osseous bridges actually connected the region of the acetabulum with the newly formed capsular structures surrounding the dislocated head of the femur. The femur was almost completely ankylosed in a position of 110 degrees flexion, 20 degrees abduction and 20 degrees external rotation. Because of the firm and painless fixation of the upper end of the femur a subtrochanteric osteotomy was proposed but the patient refused treatment.

It is also suggested that the Lorenz Baeyer (8) bifurcation operation may find an occasional application. This method has recently received favorable comment by Hackenbroch and others in cases of irreducible congenital dislocations of the hip. This operation aids in the correction of instability, pain, and limp.



Fig. 4A. Traumatic dislocation of 10 years' duration. (Patient 35 years of age, untreated.) Note well shaped secondary socket which has formed on ilium posterior and superior to primary acetabulum (arrows, the rim of acetabulum). Head of femur appears flattened and roughened.



Fig. 4B. Roentgenogram of an everted ischiatic dislocation of 3 years' duration. Note the extensive calcification of the capsular structures which surround the head. Approximately 25 degrees of flexion motion was present in the hip.

Arthroplasty Arthroplasty may be indicated if during open arthrotomy, the femoral head is seen to be roughened and arthritic and fibrous ankylosis seems probable or if after successful open reduction, the hip continues to show marked pain and limitation of motion in the presence of good musculature.

From the statistical table it may be seen that complete reduction was accomplished in every case. Some of the operations were necessarily prolonged and severe but on the whole the results were very encouraging. Follow up records show that the results were excellent in 8 cases, good in 1 case, fair in 4 cases and poor in 2 cases. In an evaluation of the success of the treatment in this series it should be repeated that the duration of the dislocations varied from 3 weeks to 4 years, with an average period of 7.7 months in all cases studied.

In order to emphasize interesting observations made during the surgical management of these cases the following records have been selected for detailed report. The first case illustrates the value of skeletal traction as a preliminary step to open arthrotomy for old posterior dislocations. The most serious complications of arthrotomy were the development of secondary infection (2 cases) and injury to the sciatic nerve (1 case). The danger of fracture during late manipulation is

shown in Case 4. Another history illustrates the development of marked hypertrophic arthritis several years after open arthrotomy. It was interesting to note that 80 per cent of the cases showed similar changes in follow up roentgenograms. Usually the arthritis was of mild nature and caused pain only upon overuse of the hip. Case 6 is added because of the very unusual etiology. In this instance a rifle bullet passed through the medial portion of the head, and caused a fracture of the posterosuperior rim of the acetabulum. It is believed that the combination of capsular tear and fracture allowed subsequent muscular pull to produce the dislocation. Fortunately infection did not follow so the dislocation was treated in the usual manner. The last 2 cases (shown only by photographs and roentgenograms, Figs. 11 and 12) are illustrative of excellent results which are obtained following open reduction.

THE VALUE OF SKELETAL TRACTION BEFORE OPEN REDUCTION

CASE 1 A Chinese male, aged 35 years, was first seen on April 2, 1931. The entrance complaint was pain and deformity of the right hip of 80 days' duration. The general physical examination and laboratory tests of blood and urine gave normal findings. The right thigh was held in a typical position of posterior dislocation—flexion (45 degrees) adduction (30 degrees) and internal rotation.



Fig. 5A. Roentgenogram showing an old traumatic dislocation of the left hip (4 years). The head of the femur is in the high dorsal position.

The great trochanter was 2.5 centimeters above Rose-Nelson's line and the measurements of Bryant's triangle were compatible with dislocation. There was approximately 4 centimeters of actual shortening. The roentgenographic report confirmed the clinical impression: in addition there was a displaced fracture of the postero-inferior portion of the acetabulum.



Fig. 5B. This roentgenogram (same case shown in Fig. 5A) was taken 3 weeks after the application of skeletal traction to the lower end of the femur. The head of the femur might appear to be within the acetabulum but it actually lies directly posterior to the socket. The dark shadow represents the upper end of the Thomas ring.

On April 10, 1931, a Steinmann pin was inserted through the lower end of the right femur. A Thomas splint was applied and traction was maintained for 10 days. The traction was started at 5 pounds and increased gradually up



Fig. 6. An obturator dislocation of 2 years' duration. Note the extensive formation of new bone in the obturator foramen. This hip was reduced by open arthrotomy through a modified Smith-Petersen incision.



Fig. 7. Roentgenogram of an old traumatic dislocation which became infected following open reduction. This picture represents the late healing stage of suppurative arthritis.



Fig. 8A. Roentgenogram showing an old traumatic dislocation of the obturator foramen (duration—years). Note that the head is completely displaced through the foramen. Also note the calcified material which surrounds the head—an indication of the primary acetabulum.



Fig. 8B. Roentgenogram from the same case shown in Figure 8A following closed reduction. A portion of the head of the femur remained within the secondary socket. The intact portion of the head was placed successfully in the acetabulum.

to 20 pounds. At the end of this period of time the head of the femur had been pulled down to the level of the acetabulum. On April 20, 93, open reduction was performed with the aid of spinal anesthesia. A Smith-Petersen incision was used. Upon dissection toward the hip joint, dense scarred mass of iliopectineus muscle was found stretched over the inferior half of the acetabulum. This was cut through and the rim of the socket was exposed. The acetabulum was filled with remnants of capsule *in situ*, and newly formed connective tissue. After this was removed, intact cartilage was seen. The head and neck of the femur were then exposed by an incision through the secondary capsule. Forceful external rotation stretched taut the scar

tissue bands of the obturator internus and piriformis tendons since both of these structures were wound around the neck of the femur and therefore lay between the posterior edge of the acetabulum and the neck of the femur. Following tenotomy of these tendons and further cutting of the scar tissue, the head of the femur was reduced rather easily. The relative ease of reduction was accredited to the



Fig. 9A. Roentgenogram of an old ectatic dislocation (—months duration) before operation. Note the fracture of the posterior rim of the acetabulum.



Fig. 9B. Roentgenogram of the hips shown in Fig. 9A, 9 years and 9 months after successful open reduction. Note the presence of marked hypertrophic arthritis. Excellent function of the hip was present.



Fig. 10A Pre-operative roentgenogram of an old gunshot fracture-dislocation of the hip (80 days). Apparently the bullet passed through the head of the femur and fractured the posterosuperior rim of the acetabulum.



Fig. 10B The same hip shown in Figure 10A after 10 days of skeletal traction. This picture was taken before the open arthrotomy. It shows that the head has been pulled down to the level of the acetabulum. Stereoscopic views revealed that the head was still dislocated posteriorly.

stretching and relaxation of the soft structures which followed preliminary skeletal traction. The wound was closed in the usual manner and a long leg hip spica cast was applied with the thigh in 25 degrees abduction.

The patient ran an uneventful postoperative course. The cast was removed 5 weeks after operation. Physiotherapeutic treatment consisting of baking, massage and active and passive motion was started and continued for 6 weeks. At the end of this time the patient was able to bear weight upon the hip without pain. Active motion was present to the extent of 80 degrees flexion, 45 degrees abduction and 30 degrees adduction. Six months later the patient stated in a follow-up letter that motion and strength of the hip were improving very satisfactorily.

In the earlier cases of posterior dislocation in this series preliminary skeletal traction was not employed and as a result many difficulties were encountered in effecting reduction even after the head and the acetabulum had been isolated. In most instances efforts at manipulation and traction failed and the head was replaced only by the use of a steel lever. Crushing injuries of the head frequently followed the application of this instrument. In the hope of overcoming such difficulties preliminary skeletal traction (technique of Van Gorder) was employed in the latter 5 cases and, in each instance it was possible to pull the head down to the level of the acetabulum before open arthrotomy. The traction was maintained for periods of time varying from 1 to 5 weeks. The weights were gradually increased from 5 pounds up to 20 or 25 pounds. Measurements of the extremity were made daily and when the length approached normal roentgenograms were taken to determine accurately the position of the



Fig. 10C The same hip shown in Figures 10A and 10B 5 weeks after open reduction. Aseptic absorption of part of the head may be seen.

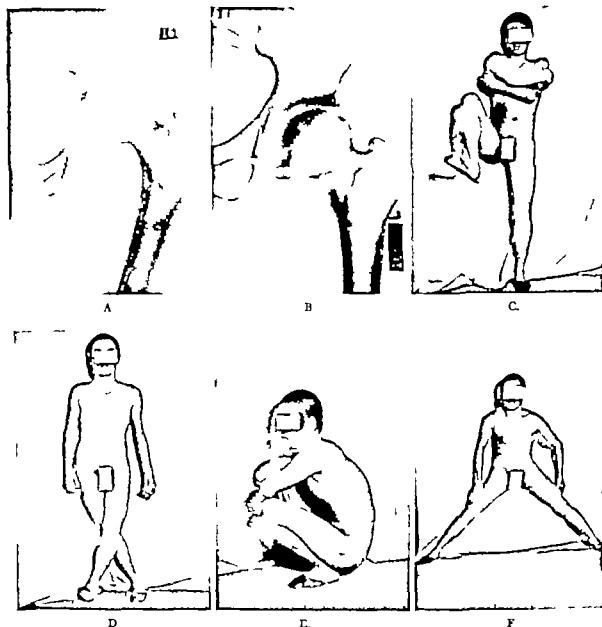


Fig. 1. Illustrations of a case of posterior dislocation of the hip with excellent result following open reduction. A Pre-operative roentgenogram of left hip, illustrating a posterior dislocation of 8 weeks' duration. B Post

operative roentgenogram of the same hip. Photographs C, D, E, and F show motion of the left hip 3.5 years after operation.

femoral head. If the X-ray films showed that the head had been pulled down to the level of the acetabulum the hip was then considered ready for open reduction. By the use of this method the trauma of open arthrotomy was decreased to a great extent and in each of the latter 5 cases

complete replacement was accomplished by gentle manipulation (Figs. 5A and B and 10A and B)

THE DANGER OF SECONDARY INFECTION

CASE 2. A Chinese male, 41 years of age, was first seen on March 23, 1925. The entrance examination was co-

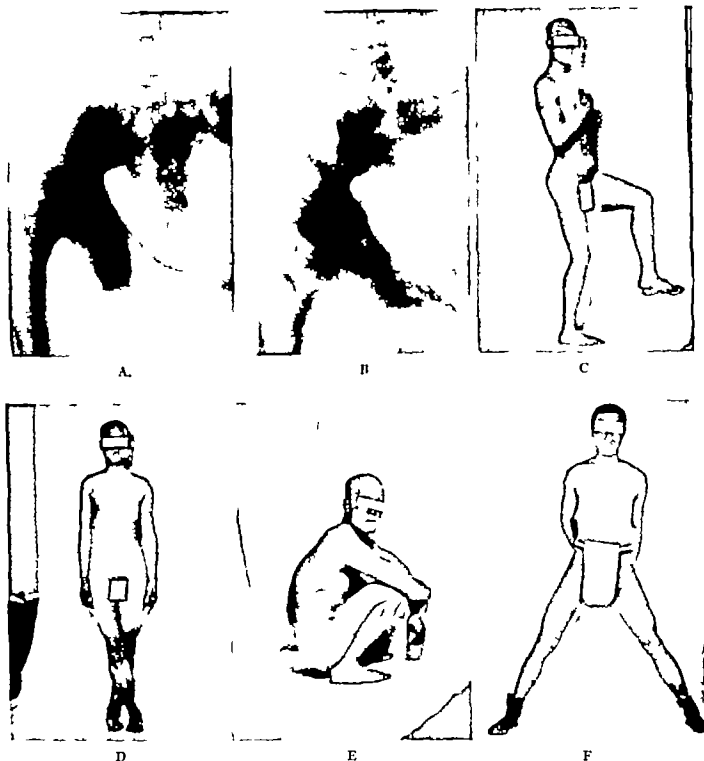


Fig. 12. Illustrations of a case of posterior dislocation of the hip with excellent result following open reduction. A Pre-operative roentgenogram of the dislocated right hip

(one year) B Postoperative roentgenogram of the same hip Photographs C D E, and F show motion of right hip 3 years after operation

essentially negative except for a posterior dislocation of the left hip which was of 8 months duration. The left lower extremity was in the characteristic position (flexion, adduction and internal rotation) and weight bearing was moderately painful. Roentgenograms showed complete backward dislocation of left femur head lying against ilium above acetabulum. A small amount of new bone was seen in secondary capsule surrounding the head of femur

Open reduction without preliminary traction was performed with the patient under ether anaesthesia. A Smith Petersen approach to the hip joint was made. The incision extending from the anterosuperior spine of the ilium downward along the lateral edge of the sartorius muscle and backward along the crest of the ilium. Dissection was continued between the sartorius and rectus femoris and between the ilium and the periosteal origins of the gluteus

TABLETATION OF CASES
Average Duration of Postoperative Observation—3 1/2 years

Age, sex	Duration of dislocation	Type	Complications of dislocation	Method of reduction	Result
26 M	2 mo	Posterior (acetic) Right side	Linear fracture of head of femur. Chip fracture of posterior rim of acetabulum. Iliopsoas tendon (7) fracture of right femur	Closed reduction (Bogrow) Supracotylar fracture treated by skeletal traction	Excellent. Complete reduction of hip. Six months later hip showed 75 per cent of normal motion. Knee showed 75° flexion with arthritic pain on over-exert
26 M	4 1/2 mos.	Anterior (subcapital) Right side	Iliopsoas dislocation of head with new bone formation	Closed reduction (reversed Bogrow) Manipulation prolonged and difficult, followed by large hematoma	Fair. Part of femoral head fractured and remaining portion of head placed in acetabulum. Fibrous ankylosis in good position. One year later considerable pain on over-exert
3 M	2 1/2 yrs	Posterior (acetic) Left side	None	Closed reduction (Bogrow)	Excellent. Motion almost complete and painless one month after reduction
3 M	2 1/2 yrs	Posterior (acetic) Right side	None	Closed reduction (Bogrow)	Excellent. Motion almost complete and painless 3 months after reduction
26 M	6 mos	Posterior (high dorsal) Right side	None	Open reduction. Posterior approach. Exposure of acetabulum very difficult. Manipulation during arthrotomy caused crushing injury to head	Fair. Reduction complete. Partial fibrous ankylosis present after 6 mos. Considerable pain on over-exert. Followed for 6 years. Chronic traumatic arthritis of hip
41 M	8 1/2 mos	Posterior (high dorsal) Left side	Some new bone formation about dislocated head	Open reduction. Anterior approach	Fair. Reduction complete but secondary infection (osteomyelitis) followed. Two years later hip ankylosed in good position. Chronic pain and disability. Observed 3 1/2 years
27 M	2 1/4 mos	Posterior (acetic) Left side	Chip fracture of posterior-inferior margin of acetabulum	Open reduction. Anterior approach	Fair. Reduction complete but secondary infection (osteomyelitis) followed. After one year ankylosis in good position with painless weight bearing hip. Observed 4 years
10 M	1 mos	Posterior (acetic) Left side	Healed fracture of head. Marked osteoporosis	Open reduction, anterior approach. During arthrotomy head of femur bruised	Good. Reduction complete. Partial fibrous ankylosis. Function of hip good. Observed 2 months
30 F	2 mos	Posterior (acetic) Left side	Chip fracture of posterior superior acetabular rim	Open reduction, anterior approach	Excellent. Reduction complete. Motion and function 95 per cent after one year. Observed 7 years
40 F	2 mos	Posterior (acetic) Right side	None	Open reduction, anterior approach	Excellent. Reduction complete. Patient developed useful range of painless motion. Observed 2 months
34 M	2 mos	Posterior (acetic) Left side	Bullet struck head of femur causing posterior dislocation of hip with fracture of head and superior rim of acetabulum. No infection	Pre-operative skeletal traction very effective. Open reduction, anterior approach	Excellent. Reduction complete. Fibrous ankylosis of hip in good position. No infection. Observed 4 months
28 M	2 mos	Posterior (high dorsal) Right side	Chip fracture, posterior rim of acetabulum	Pre-operative ankylosis (Bock's) ineffective. Open reduction. Anterior approach	Excellent. Reduction complete. Almost normal range of motion. Slight traumatic arthritis present after 3 mos
26 M	2 mos	Posterior (acetic) Right side	Marked osteoporosis of head and neck. Some flattening of the head probably due to old crushing injury	Pre-operative skeletal traction very effective. Mild osteomyelitis in lower end of femur (osteomyelitis) Healed after several months. Open reduction, anterior approach	Fair. Reduction complete. Marked osteoarthritic changes developed in hip with limited motion and pain on over-exert. Observed 3 mos
2 M	7 yrs	Posterior (acetic) Left side	None	Pre-operative skeletal traction very effective. Open reduction, anterior approach	Fair. Reduction complete. Sciatic nerve severed during arthrotomy. Hip arthrotomy. Hip ankylosed in good position with satisfactory weight bearing. Observed 4 years
3 M	3 mos	Posterior (acetic) Left side	Healed chip fracture of posterior acetabulum and top of great trochanter	Pre-operative skeletal traction very effective. Open reduction, anterior approach	Excellent. Reduction complete. Motion was 80 per cent normal after one year. Function very good. Hip ankylosed 3 1/2 mos
33 M	3 mos	Posterior (high dorsal) Right side	Healed chip fracture of posterior acetabulum	Pre-operative skeletal traction very effective. Open reduction, anterior approach	Excellent. Reduction complete. Motion was 80 per cent normal after 7 months. Function very good. No pain

minimus and medius muscles. This exposed the entire region of the acetabulum and showed it to be filled with dense tissue across which stretched the scarred tendinous mass of the iliopectineus muscle. The mass of scar tissue was dissected out piece by piece revealing intact cartilage within the acetabulum. After the head and neck of the femur were freed from the adjacent scar tissue an attempt was made to reduce the dislocation. This failed despite the fact that great force was used in pulling down the leg and manipulating it. Further attempts also failed until finally with the help of a large steel skull reduction was completed. During the latter procedure a portion of the head of the femur was bruised and the cartilage torn off despite all efforts to prevent injury. The wound was closed in the usual manner and the leg was placed in a splint in a position of 30 degrees abduction.

Following this operation the patient's temperature varied from 38 to 40 degrees centigrade. Five days later the wound was reopened because of obvious secondary infection. A staphylococcus osteomyelitis of the hip followed and two incisions were necessary for drainage. The infection was rather severe and was followed by extensive destruction of the acetabulum and of the head of the femur. Roentgenograms taken 6 months later showed definite bony ankylosis of the hip (Fig. 7). The patient was able to walk satisfactorily. The patient was under observation for 3 years, during which time he suffered from several attacks of pain associated with renewed drainage from the hip.

OPERATIVE INJURY TO THE SCIATIC NERVE

CASE 3. A Chinese male aged 18 years, was first seen on April 3, 1920. The entrance examination revealed a posterior dislocation of the left hip which was the result of a fall 4 years previously. Roentgenograms showed that the head of the femur was lying on the ilium in the region of the greater sacrosciotic notch. The upper portion of the head appeared somewhat flattened and osteoporotic as a result of the old injury. The general physical examination was essentially negative except for the condition of the hip.

On April 9, 1920 traction was started by means of a Steinmann pin inserted through the lower end of the femur. The weights were gradually increased up to 15 pounds and traction was continued for 5 weeks. At the end of this time roentgenograms showed that the head of the femur had been pulled down to the level of the acetabulum. Its anterior surface resting against the posterior margin of the socket. On May 17, 1920, open arthrotomy was performed. Ether anesthesia was used and a Smith Petersen incision was made. Exploration showed that the acetabulum was filled with dense fibrous tissue. This mass of tissue was removed exposing the intact cartilage. The secondary capsule was opened anteriorly and upon external rotation a portion of the head could be seen. The upper end of the shaft and the neck were held securely to the pelvis posterior to the acetabulum. When the fibrous bands were cut through, a branch of the superior gluteal artery was severed. Considerable hemorrhage followed and while we were working in a rather bloody field the sciatic nerve was divided. Apparently the nerve had been fastened to the posterior surface of the secondary capsule. Following the hemorrhage the patient showed a weak pulse and in the hurried dissection which followed, repair of the sciatic nerve was not performed. The head of the femur was completely reduced. A transfusion of blood was given immediately after the operation and the patient returned to the ward in satisfactory condition.

Two weeks later repair of the sciatic nerve was attempted but the proximal portion had retracted into the pelvis so

that end-to-end anastomosis was impossible. The hip was immobilized and 4 months later fibrous ankylosis was almost complete. Observations 1 and 3 years later showed that the hip was ankylosed in good position. The patient walked satisfactorily with the aid of a footdrop brace.

A FRACTURE CAUSED BY LATE MANIPULATION

CASE 4. A Chinese male aged 36 years was first seen on July 1, 1925. Four and one half months previously he had been thrown from a wagon in such a manner as to dislocate his right hip. The general history and physical examination revealed nothing of importance. The results of routine laboratory tests of the blood and urine were normal. Local examination showed the right lower extremity to be in a position of 40 degrees abduction, 45 degrees external rotation and 45 degrees flexion with actual lengthening to the extent of 3 centimeters. Roentgenographic examination revealed that the head of the femur was totally displaced through the posterior part of the obturator foramen (Fig. 8A). A layer of dense bony material covered most of the surface of the dislocated head. This appeared to be calcified ligamentous and perosteal tissue. The inferior rim of the acetabulum was fractured but the femoral head seemed intact except for a moderate amount of osteoporosis.

On July 10 closed reduction was performed with the patient under ether anesthesia. During the manipulations which were necessarily very severe and prolonged (1 hour) a cracking sound was heard. Following this the head of the femur slipped into the region of the acetabulum. A splint was applied and the patient returned to the ward in good condition. Roentgenograms taken immediately after the manipulation showed that reduction was quite satisfactory but at the expense of a fracture through the head. Several broken fragments of the femoral head remained in the obturator foramen (Fig. 8B).

Following the trauma of reduction a large hematoma developed in the right groin and for 8 days the patient ran a fever varying from 38 to 39 degrees centigrade. Two weeks after reduction a course in baking massage and active and passive motion was instituted. Two months later the patient walked upon the right leg but still complained of pain. He then had about 60 degrees of flexion but motion in other directions was greatly limited. In a follow up letter one year later the patient stated that the hip was painful upon bearing weight but nevertheless was greatly improved when compared to the previous condition.

LATE ARTHRITIS FOLLOWING OPEN REDUCTION

CASE 5. A Chinese male aged 28 years, was admitted to the hospital on August 23, 1926. The patient stated that 12 months previously he had fallen from a tree injuring severely the right hip. The entrance examination was essentially normal except for the right hip which was carried in the usual position of posterior dislocation. Roentgenograms showed the head of the femur lying on the posterior surface of the ilium in the region of the great sacrosciotic notch (Fig. 9A).

Traction by means of adhesive tape was maintained for 21 days, but had little effect on the measurement of the distance between the anterosuperior spine and the internal malleolus. On September 3, 1926 open reduction was performed. Ether anesthesia was used and a Smith Petersen incision made. Following deep dissection, a triangular flap of skin, fascia, muscle and periosteum was retracted from the blade of the ilium. Superficial dissection gave very satisfactory exposure of the acetabulum and the dislocated head of the femur. The acetabulum was filled entirely with fibrous tissue the removal of which required force and sharp dissection. Intact surfaces of cartilage were found.

When the secondary capsule was opened the head of the femur was found in the region of the greater sciatic notch. The cartilaginous surface of the head was intact except in one small area where it appeared thinned and flattened as though the underlying bone had been crushed. The tendinous fibers of the obturator internus and pyramidal muscles lay in a mass of scar tissue which firmly held the base of the neck of the femur to the posterior margin of the acetabulum. These two tendons had been wound around the neck as they passed on to their insertions into the region of the great trochanter. After the upper end of the femur was released by sharp dissection, reduction was obtained by manipulation and traction. A long leg hip brace cast was applied and the patient had an uneventful convalescence.

Following 3 months of physiotherapeutic treatments, the functional result was excellent, with almost 75 per cent of the normal range of motion. On November 3, 1930 (3 years after operation) the patient returned for follow-up examination. The only complaint was slight pain after long periods of walking. Roentgenograms taken at that time showed that a large amount of new bone had developed around the head and neck of the femur (Fig. 9B). It was very surprising to find excellent function existing in the presence of such marked osteo-arthritis changes.

POSTERIOR DISLOCATION OF THE HIP CAUSED BY THE TRAUMA OF A RIFLE BULLET

CASE 6. A Chinese male, aged 34 years, was first seen on June 30, 1930, for an old gunshot injury (80 days) in the region of the left hip with retained foreign body. The wound had healed spontaneously a week after injury. The general physical examination was normal except for the condition of the hip. The laboratory examinations revealed no abnormal findings. The left thigh was held in a position of flexion (35 degrees) adduction (30 degrees) and internal rotation, and the greater trochanter was 4 centimeters above Nélaton line. Roentgenographic examination of the hip confirmed the impression of posterior dislocation. It also showed a fracture of the head of the femur along with a fracture of the superior rim of the acetabulum (Fig. 9A). The foreign body was seen in the region of the left obturator foramen. There was no evidence of any infectious process in the hip.

On June 3, 1930, a Steinmann pin was inserted through the lower end of the femur and preliminary traction was started. Seven days later on July 1, 1930, the leg had been pulled down to its normal level (Fig. 10B). Three days later an open arthrotomy was performed through Smith-Petersen incision. All the scar tissue was cleaned out of the acetabulum. Upon opening the capsule, the head of the femur was seen to be fragmented in the inferior portion—changes suggesting the gradual absorption seen in aseptic necrosis (Auchincloss, Pfenister). Cultures taken from the head showed no growth. The dislocation was easily reduced by manipulation. The wound was closed in the usual manner and a plaster hip brace was applied with the thigh in position of 30 degrees' abduction. The patient had an uneventful convalescence and was discharged in a cast 13 days after operation. One month later the cast was removed and physiotherapy was started. Roentgenographic examination at that time showed an increased amount of absorption of the injured area of the head and acetabulum

(Fig. 10C). Three months later the patient walked satisfactorily. The hip had undergone almost complete fibrous ankylosis. One year and 3 months following the operation the patient reported that he was able to work 7 hours daily. His only complaint was slight pain in the hip upon overuse.

SUMMARY

1. A review and discussion of the reconstructive surgery of old traumatic dislocations of the hip is presented.

2. Sixteen cases of old traumatic dislocation of the hip (15 posterior, 1 anterior) are reported. Three cases of 21 to 31 days' duration were reduced by closed manipulation after the method of Bigelow. One case of obturator dislocation of 4½ months' duration was reduced by the closed method at the expense of fracture of the head of the femur. By open arthrotomy complete reduction was accomplished in the 12 remaining cases.

3. The use of skeletal traction preliminary to open arthrotomy is emphasized.

Acknowledgment is due to Drs. C. W. Van Gorder, A. S. Taylor, J. P. Webster and L. C. Chen, whose cases are included in this study.

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A TYPE OF PELVIS INTIMATELY ASSOCIATED WITH OCCIPITO-POSTERIOR POSITION

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IN speaking of the differences in the configuration of the human pelvis William Turner in 1886 wrote 'with the exception of the skull no portion of the skeleton presents greater individual variations than the pelvis. These variations may have a profound effect upon the course and character of labor as is well known to obstetricians, and the pronounced types of contracted pelvis are well known and readily recognized. On the other hand there are many slight or moderate variations from the normal which remain unrecognized.

In the present paper I wish to speak of pelvis in this latter group especially those characterized by a moderate or pronounced shortening of the transverse diameter of the superior strait often in association with abnormal lengthening of the anteroposterior diameter. I am convinced that this type of pelvis occurs with relative frequency, and that it has a distinct influence upon the course of labor, two facts that have not been sufficiently emphasized. My conclusions are drawn from a radiological study of pelvis now extending over twelve years. This experience has proved to me what I have on numerous occasions emphasized, namely, that the usual methods of external pelvimetry do not offer an accurate picture of the superior strait and at best can be considered only as guideposts to the true dimensions of this plane of the pelvis. It is therefore not surprising that moderate or even pronounced shortening of the transverse diameter of the superior strait should escape recognition for until the advent of roentgen methods there was no accurate diagnostic procedure available for pelvic mensuration of the superior strait.

It is an interesting historical fact that the plate depicting the pelvis in the great work of Vesalius shows the sacrum with six instead of five segments, so also does Deventer's, *New Light for Midwives* 1725. Sacral bones containing six segments are definitely associated with transverse shortening of the superior strait so that these plates do not depict what the authors undoubtedly intended, namely the normal pelvis.

In all mammals except man the transverse diameter of the superior strait is shorter than the anteroposterior. This relationship is known as the dolichopelvic pelvis in contrast to the platy-

pelvic pelvis in which the obverse obtains, namely the transverse is longer than the anteroposterior diameter. The platypelvic pelvis is characteristic of the human species. The dolichopelvic pelvis obtains throughout in the anthropoid apes and Turner states that when it occurs in humans there exists an 'animalized' arrangement.

In the pelvis of the newborn child the superior strait is narrower than in the adult, the ratio of the anteroposterior to the transverse diameter being 100:105 instead of 100:122.5 as in the latter. Fehling first pointed out that differences in form and appearance of the male and female pelvis are noted as early as the third month of fetal life and Thompson noted at this period differences similar to those of the adult. In his series the male index was 86 as against the female index of 83.

$$\text{Pelvic Index} = \frac{\text{Conjugate diameter} \times 100}{\text{Transverse diameter}}$$

When we study the essential differences of the adult male and female pelvis, we find among other characteristics that the transverse diameter of the superior strait in the male is shorter than that of the female, thus giving this plane in the former a more rounded appearance.

Berry Hart states that the ultimate shape of the pelvis is due mainly to a type growth before birth and not wholly to postnatal mechanical influences. He concludes nevertheless that the lumbar curve, the greater curve of the sacrum and the inclination of the pelvic brim to the horizon are all due to postnatal influences. He has thus classified the more common pelvic variations in this interesting manner:

Congenital which include

- 1 Normal female
- 2 Inverted pelvis (i.e., male type)
- 3 Justominor
- 4 Naegele
- 5 Robert
- 6 Achondroplastic
- 7 Infantile
- 8 Funnel
- 9 Assimilation

Postnatal which include

- 1 Flat
- 2 Flat rachitic
- 3 Scoliorachitic

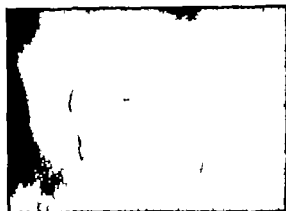


Fig. 1. Roentgenogram of pelvis showing unilateral high assimilation. Anteroposterior diameter o centimeters transverse diameter x centimeters

In the above classification the inverted or male type pelvis is of unusual interest to us because its characteristics are

1. Smaller ilium
2. Smaller sacrum
3. Male type sacrospinous notch
4. Symmetry of pelvis
5. Narrowing of transverse of brim

Nearly every textbook of obstetrics mentions the occurrence of the male type of pelvis in the female. When we consider that the essential difference from an obstetrical viewpoint is a decrease in the transverse diameter of the superior strait and of the outlet. It is reasonable to suspect that these changes may exert a definite influence on labor. In a recent paper by Cornell on "The Conduct of Labor in the Dystocia Dystrophica Syndrome Patient" although no specific attention was given to the exact type of pelvis present in the series (that is no outlet or X-ray measurements are mentioned) the description of the heaviness of the pelvic bones, the *relative increase in the external conjugate diameter* and the frequent occurrence of occiput posterior position leads me to the conclusion that shortening of the transverse diameter of the superior strait is probably also present in this type of patient.

Shortening of the transverse diameter of the superior strait is also characteristic of the high assimilation pelvis. It will be recalled that in this variation the transverse processes of the last lumbar vertebra fuse with those of the first sacral. By this process the last lumbar becomes the first sacral vertebra, the sacrum then being composed of six instead of five segments.

Occasionally in high assimilation one side of the last lumbar vertebra undergoes this fusing

TABLE I—SUMMARY OF FIGURES

Case	Anteroposterior diameter cm	Difference	Transverse diameter cm	Course of labor
1	75	+ 75 =	75	L.O.P. forceps
2	75	+ 5 =		R.O.P. primary
3	85	- 25 =	55	R.O.P. persistent
4	5	+ 5 =		R.O.P. primary
5	4	- =	3	R.O.P. persistent, forceps
6		+ 75 =	75	R.O.P. persistent, forceps
7		+ 75 =	75	L.O.P. primary
8		- =		R.O.P. persistent, forceps
9	75	+ 1 =	75	R.O.T. low transverse or arrest, forceps
10	75	- 3 =	5	R.O.P. persistent, forceps
11		- =		R.O.P. primary
12		- 3 =		R.O.P. primary
13	3	- 75 =	5	R.O.P. primary
14	3	- 3 =		R.O.T. small baby (5 lbs. grams)
15		+ 1 =		L.O.T. low transverse arrest, forceps
16	75	- =	75	R.O.P. primary
17	75	+ 3 =	75	R.O.P. primary forceps from R.O.T.
18	75	+ 3 =		L.O.P. persistent, forceps
19		+ 30 =	5	R.O.P. persistent, forceps
20	55	- 30 =	75	R.O.P. primary

process while the other side does not, as is shown in the accompanying roentgenogram (Fig. 1). In Paterson's study of 265 dried pelvis this unilateral assimilation occurred in 18 or 6.79 per cent, while 61 or 23 per cent, showed the presence of more than five sacral vertebrae. Emmons, in an analysis of 317 Indian squaw pelvis, found the incidence of assimilation to be 21.7 per cent.

From these studies we conclude that high assimilation is of relative frequency and is definitely associated with shortening of the transverse diameter of the superior strait. Indeed occasionally this variation of the pelvis gives rise to a dolichopelvic pelvis.

One of the most interesting clinical reports on this subject is that of Fabre and Trillat in 1920. They record the results of a radiographic study of 12 pelvis which they designate as "Pelvis with anteroposterior diameter predominating." In all of their series the fifth lumbar vertebra was sacralized, i.e. high assimilation was present. In seven of these, delivery occurred with the occiput posterior. Fabre and Trillat conclude "for us this has the relation of cause and effect and



Fig. 2. Roentgenogram of pelvis (dolichopellic type). Anteroposterior diameter 13.0 centimeters transverse diameter 11.0 centimeters.



Fig. 3. Roentgenogram of pelvis (dolichopellic type). Justomajor external measurements anteroposterior diameter 13.0 centimeters transverse diameter 12.5 centimeters.

we believe that this special form of the superior strait which we have shown in radiographic measurements and to which we have applied the name pelvis with anteroposterior diameter predominating is the principal cause of births in the occipitoposterior position.

I am convinced that not only are such pelvises as these authors describe associated with occipitoposterior position but that lesser degrees of transverse contraction whether due to assimilation, male type of pelvis or to unnamed causes are definitely associated with both primary and persistent occipitoposterior position. I am also of the opinion that many pelvises which from their external measurements are classified as generally contracted are contracted only or chiefly in the transverse diameter of the superior strait. These are the so called small round pelvises. In many of these the diagonal conjugate diameter is within the limits of normal.

During the past year in connection with our roentgen pelvimetry and cephalometry studies I have been impressed with the frequency of the occurrence of pelvises in which the chief deviation from normal is a relative or real decrease in the transverse diameter of the superior strait. Twenty such pelvises have been studied particularly in reference to the course of labor.

The first 16 of this series have been reported in detail in another publication. An important point in this study is the fact that the series represents 20 consecutive cases of this type and that every one was associated with primary or with persistent occipitoposterior position.

A summary of the figures obtained from our study is shown in Table I.

The diagnosis of position in all instances was made by vaginal examination during labor. Those cases which are designated as primary posterior position subsequently delivered with the occiput anterior while in 2 cases which were delivered by forceps from low transverse arrest I assume the occiput entered the pelvis in the posterior position. In only 2 instances did the transverse diameter of the superior strait exceed the anteroposterior diameter by as much as 1.0 centimeter (normal 2.5) while in one instance in a patient with justomajor external measurement the transverse diameter was actually less by 2.5 centimeters than the anteroposterior diameter a true dolichopellic pelvis.

I regret that in this group I cannot report upon the incidence of high assimilation. In order to determine accurately the presence of this entity either lateral or direct anteroposterior pelvigrams should be taken. In the system of roentgen pelvimetry which we employ it is not possible in the developed film to count the sacral segments. Nevertheless in one case of outspoken transverse diameter shortening a lateral pelvigram showed only the usual number of sacral vertebrae. My belief is that shortening of the transverse diameter of the superior strait does occur frequently in the absence of high assimilation or other outspoken pelvic anomaly.

In reviewing our findings, I am mindful of a sentence from the writings of Sir Oliver Lodge which reads 'always we must be guided by experience and be loyal to facts whether we understand them or not.' The facts stated are cer-

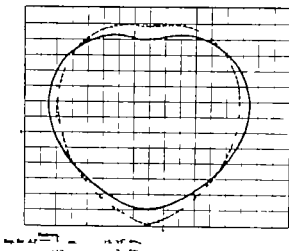


Fig. 4. Normal pelvis, solid line; composite pelvis, dotted line.

tainly interesting and certainly not easy of complete understanding. When one surveys statistics dealing with the incidence of posterior presentations, he becomes involved in a maelstrom of figures which are largely meaningless. Thus Pinard gives an incidence of 38.8 per cent while Williams, in a large series, reports 11.68 per cent. The latter writer however states that the incidence is probably twice this figure. I think that 20 per cent for primary occipitoposterior positions probably represents a figure somewhere near the truth. It is, of course, an interesting speculation as to the real cause of the high incidence of occipitoposterior position in the series here presented. My own interpretation of the facts may be stated briefly. If we consider 11 centimeters for the normal conjugata vera and 13 centimeters for the normal transverse of the inlet, and apply them to the figures for these diameters in the above series we see two interesting facts. First, in 17 of the 20 cases the transverse diameter is less than the normal figure, and in 14 of the series the anteroposterior diameter actually exceeds the normal figure. The average figures are transverse diameter 13.1 centimeters less than the normal, conjugata vera 1.75 centimeters more than normal. If we visualize these figures in the accompanying diagram (Fig. 4), the solid line representing the normal pelvis and the dotted line representing a composite pelvis based on the figures mentioned. I think we can agree that the occiput would assume a primary posterior position much more readily in the latter than in the former. I am well aware that other factors may

enter into the cause of occipitoposterior position. When one reads the amazing list of suggested causes in modern textbooks the aggregate is most bewildering. However I am convinced that the shape of the pelvis and particularly the type of pelvis present in this series, is a most potent factor in the production of primary occipitoposterior position. In reducing this type of pelvis to an entity in which the chief variations seem to be a prolongation of the anteroposterior diameter in combination with a moderate shortening of the transverse diameter it may appear like putting the cart before the horse to call it a transversely contracted pelvis perhaps the elongated anteroposterior pelvis is more descriptive.

I summarize my impressions as follows:

1. The type of pelvis described here is far more common than heretofore appreciated.
2. The extraordinary incidence of primary and secondary occipitoposterior positions noted indicate that this type of pelvis is a most potent factor in the production of this position.
3. Unless we make an accurate survey of the pelvis of every primiparous patient we are not doing our whole duty to the patient or practicing modern scientific obstetrics.
4. At the present time an accurate survey of the superior strait in the living subject can only be secured by roentgen pelvimetry.

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ROENTGEN MEASUREMENTS IN PREGNANCY

A FEW PRACTICAL METHODS AND A SIMPLIFIED PROCEDURE USED BY THE AUTHOR

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THE taking of pelvic measurements in obstetrics in some manner or another is nearly as old as the subject of obstetrics itself. As the study of pelvimetry as a diagnostic procedure advanced, it was found and generally conceded that external pelvic measurements were not indicative of the size of the inner pelvis as they were formerly thought to be and it was therefore concluded that the only pelvic measurements of any value were those obtained by taking internal measurements. For this latter type of procedure many methods and many instruments were devised. In some hands this procedure seemed to have considerable value in obtaining the desired information regarding the size and shape of the inner pelvis. The chief objections however have been mainly the distress it causes most patients and the lack of ability in the hands of many to obtain what could be called accurate results.

To know the exact size and shape of the true pelvic inlet is admitted by all to be of extreme diagnostic value in any obstetrical procedure. It is also true that the size and shape of the superior pelvic strait is more important than is that of any other pelvic region due chiefly to the fact that this location is most subject to variation in any disease of the bones of the pelvis.

The false pelvis which is formed by the flaring of the iliac bones above the opening of the true pelvis is of very little importance in the conduct of labor. During pregnancy it gives some support to the fetus and is instrumental in directing the head of the child into the true pelvis just prior to or at the time of labor.

The true pelvis itself is an elongated curved canal composed of bony, fibrous, and muscular tissue. This canal is also made up of three anatomical regions, the entrance or inlet, the canal proper and the outlet. It is the entrance of this true pelvis that we are particularly interested in for the reason stated.

While it must be admitted that many other things enter into the successful conduct of labor, such as the strength of the uterine muscle, the relaxation of the iliopectineal muscles and the other soft tissues, the condition of the patient's kidneys, her heart and her general mental and physical makeup, nevertheless, the size and shape of the pelvic inlet remain as a diagnostic element of ex-

treme importance. As the size of the child's head is fairly constant and not subject to much variation, the size and shape of the inlet is considered the most important.

In contrast to the waning methods of internal pelvimetry by manual and instrumental means, we now have the gradual advancement of the more popular procedure of roentgen pelvimetry and its associated method cephalometry. The major part of this work, however, at the present time is still confined to the larger medical centers, their teaching hospitals and radiological laboratories, and it is no fault of the procedure that at the present time it is not more universally used. There are, however, two conditions preventing this method from being more generally in vogue. One is a lack of knowledge of the procedure among many practitioners interested in obstetrics. The other is an opinion among many that the method involves extreme technicalities and can only be performed in highly specialized X-ray laboratories. This latter statement is not true and there are many physicians today, both in large and small communities, doing obstetrics who have their own X-ray laboratory or who have access to X-ray laboratories in the hospitals in which they work, who could with very little effort make use of this valuable diagnostic procedure.

When we stop to consider that in this country alone upwards of twenty thousand women annually lose their lives from some complication of childbirth and that more than three times as many infants die at the time of birth, we will have to admit that the medical profession in this respect have a very fertile field of endeavor. And not only have we that to consider, but it is also true that upward of one half of the gynecological operations performed are with the idea of correcting some condition that had its inception at the time of childbirth. Good obstetrics like every other field of medicine and surgery is dependent upon good diagnosis.

The subject of roentgen pelvimetry as a diagnostic procedure in obstetrics is older than one would ordinarily imagine. The roentgen rays or X-rays, as they were called at the time, were discovered by Roentgen in the fall of 1895. Scarcely 2 years had elapsed when Budin published an article in which he brought out the fact that it was



Fig. 1. Pubic scales used by Rowden

more important to know the shape and circumference of the superior pelvic strait than that of the anteroposterior diameter. This article was based on the findings of a roentgenogram of a deformed pelvis.

This same year 1897 Varmer wrote his first article entitled *Pelvigraphie et pelvimetrie par les rayons x* (Pelvic photographs and pelvic measurements by the use of X-rays). In this article he states that in the year 1896 in conjunction with other collaborators, work was begun on roentgen pelvimetry. The first roentgenograms were taken on the body of a woman who had died of intestinal obstruction 9 days following confinement. He also found that, due to the limited capacity of their X-ray equipment it was very difficult to get roentgenograms that were very distinct, especially in large women or women in the latter half of pregnancy. In conclusion he remarks that it is possible by the use of X-rays to diagnose pelvic conditions that could not be diagnosed by any other means.

Albert, in 1899, published a very classical article entitled *Ueber die Verwertung der Roentgenstrahlen in der Geburtshilfe* (The use of X-ray in gynecology). The author advocated the use of the semi-recumbent position in order to get the superior strait in a parallel position with the film. He also used the upper margin of the fifth lumbar vertebra and the superior part of the symphysis as his locations for placing the superior strait in this parallel position. His calculations were made by a mathematical procedure in which known quantities, distance of superior strait from film, and focal distance of the tube were used.

Fabre and Fouchert in this same year wrote of their first work and described what is now commonly known as the Fabre method. The work of Budin, Varmer, Albert, and Fabre and Fouchert at this early stage seemed to establish roentgen pelvimetry as a definite procedure and was the foundation from which the later work received its incentive.

From then on until the present time the British, French, German, and American workers have pre-

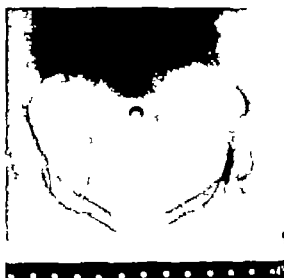


Fig. 2. Roentgenogram of pelvis with scale attached as used by Rowden.

sented a succession of articles pertaining to this subject. These articles describe a variety of procedures and at the present time we have a great many valuable methods from which to choose.

Hirsch in the discussion of a paper by Thoms (28) in 1922 divided the various methods of roentgen pelvimetry into 5 types, comparative, teleroentgenographic, frame, triangulation, and stereoroentgenographic methods. The classification is very complete and covers the entire field of roentgen pelvimetry from its inception.

1. *Comparative*. Radiograms taken of dried pelvis. These are compared with radiograms of pelvis of living individuals. A matching of radiograms, so to speak, and the referring back to the original dried pelvis for measurements.

2. *Teleroentgenographic*. By establishing a long focal film distance with the superior strait of the pelvis parallel to the film, distortion is reduced to a minimum.

3. *Frame*. By this method a scale is superimposed at the same level at which the measurements are to be taken and when an exposure is made, the scale superimposed on the film, is distorted in the same proportion as the region to be measured. Measurements are then read directly on the film from the distorted scale.

4. *Triangulation*. A study of triangles with known quantities, the procedure involving the same principles of mathematics and radiology as used for the localization of foreign bodies.

5. *Stereoroentgenographic*. Patient is first placed in such a position that the obstetrical land-

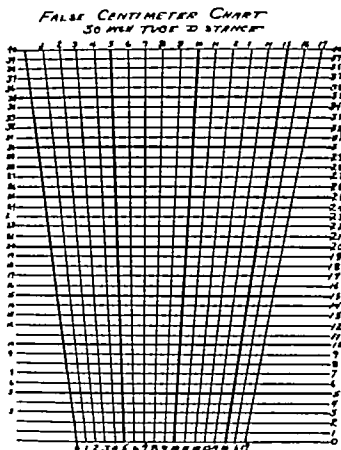


Fig. 3. Distorted centimeter graph as used by Walton

marks to be used will best be seen on the film. Stereoscopic roentgenograms are taken with a known tube shift and a known focal distance. The film center must be known in relation to the focal point and the shift of the tube must be parallel to the film. Computations must be made by the use of precalculated tables and formulas or by means of mechanical devices used to reconstruct the problem involved.

I have classified the procedures according to the recognized methods in vogue today. They are as follows: (1) methods based on mathematical calculations alone; (2) methods based on mathematical calculations associated with triangulation and stereoroentgenographic procedures; (3) scale methods.

The two latter types are the ones most commonly used today.

The past 2 or 3 years seem to have divided the workers in roentgen pelvimetry into two schools. The one class striving for extreme accuracy but involving technical methods beyond the scope of the average physician, but methods well adapted to technical laboratories or in teaching hospitals; on the other hand a group of workers striving for practical methods easily performed and entailing the least amount of technical procedure but still



Fig. 4. Type of pelvimeter used by author. Somewhat similar in appearance to that of Thoms.

maintaining enough accuracy for all practical purposes.

There is no doubt but that each group has excellent reasons for the methods advanced, but it is also true that if roentgen pelvimetry is to be a thing of real worth, it will have to be of such a nature that it can be used and understood by the great majority of physicians doing obstetrics throughout this land. It will have to be practiced in the regions where twenty thousand women are annually losing their lives from complications of childbirth.

From a roentgenological standpoint every primipara and every woman who gives a history of difficult labor when reporting to her physician and the diagnosis of pregnancy has been made should have a roentgenogram taken to determine the dimensions and shape of the pelvic inlet. If it is found at this time that the patient has a small or distorted pelvic inlet, the regular routines of diet and general care that are usually used can be followed out. Just prior to labor a roentgenogram can be taken to determine any evidence of distortion and if such is manifest the physician can resort to cephalometry.

Every case whether primipara or multipara should have a roentgenogram taken at approximate term to determine and diagnose the position of the child, the probability of multiple pregnancy, the possibility of malformed fetus and the possibility of disproportion between the pelvic inlet and the head of the child. If there is any evidence of disproportion cephalometry can be resorted to. If any other abnormal condition is found, the physician can then plot his course as regards each individual case.

If that type of procedure along with the better present day methods of prenatal care is adopted and adhered to a few years should show some results. The more prenatal care the less natal and postnatal trouble.

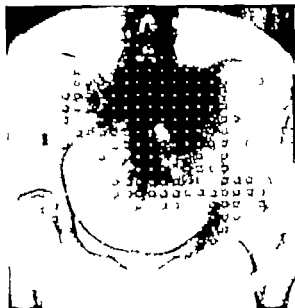


Fig. 4. Type of scale superimposed on film by pelvimeter as used by Thoms. Pelvic measurements are made by counting spaces made by dots between points to be measured.

is located and a mark placed on the mother's abdomen at a point above the center of the child's head. A mark is also placed on the lateral abdominal wall opposite the center of the child's head. The distance of the center of the child's head from the film in the plane at which the measurements are to be taken must be known.

The first exposure is made above the center of the child's head at a thirty inch focal film distance. The second exposure is made lateral over the lateral mark on the mother's abdomen at a focal film distance of thirty inches. The fronto-occipital and biparietal diameters are measured with calipers on the film and the corrected measurements are made on the chart.

METHOD OF THOMS

Thoms (32, 33) of New Haven, Connecticut has done a large amount of work on roentgen pelvimetry over a period of some years. His contributions to the subject have been many, and throughout the course of his work he has always adhered to procedures which have been practical and which are classified as scale methods. The scale he has been using for the last few years consists of a lead plate the entire surface of which is perforated with small holes (Fig. 5). These holes are placed at the intersection of lines running horizontal and vertical which are 1 centimeter from



Fig. 5. Type of scale superimposed on film by pelvimeter designed by author. Note the small dots.

each other. When this scale is reproduced on the film it causes the film to be covered with small dots which are an equal distance apart and the spaces between which are distorted in proportion to the distance that the scale is removed from the film.

The procedure of Thoms is as follows: A small piece of adhesive is placed over the spine at the region of the junction of the fourth and fifth lumbar vertebrae. The patient is placed over the film in a semi-recumbent position. In the work of Thoms, I see no mention of him using a Bucky diaphragm and it is my opinion that he uses none. The tube is centered over the pelvis about 5 centimeters posterior to the symphysis. A plumb line is dropped from the frame of the tube holder to the top of a symphysis and this gives the location of that region. The distance of the adhesive tab on the back to the film is measured with calipers. A straight line drawn through the adhesive tab and the tip of the plumb line passes through the plane of the pelvic inlet.

An exposure is now made and the patient is then removed from the table. The lead scale is then placed in the plane of the pelvic strait which previously was located by the height of the adhesive tab from the film and the tip of the plumb line. A short exposure is now made which imprints the scale (Fig. 8) on the film. It is not necessary for the pelvic strait to be parallel with the film in this procedure but for accuracy in lo-

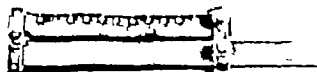


Fig. 10 Flexible ruler with centimeter scale used for making measurements by author's method

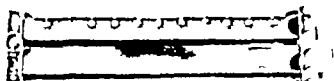


Fig. 11 Flexible ruler extended, showing distorted scale. Each centimeter distorted an equal and proportionate amount

ating the sacral promontory it should be nearly so. The corrected measurements are made by reading the number of spaces between dots connecting the points desired to be measured. This gives the various diameters directly in centimeters.

The procedure for cephalometry is similar, the scale being superimposed in the same plane as the region of the head to be measured.

The method is very practical and logical. There is nothing in the procedure but what can be duplicated by a physician or radiologist with average equipment and average ability.

METHOD OF AUTHOR

In the method I have just recently devised and which I am using at the present time, the procedure is similar to that of Thoms in that a sheet lead scale is superimposed in the plane of the pelvic strait. The variation comes however in the type of scale used and the method of making the measurements. The procedure is as follows:

A point on the spine at the upper border of the fifth lumbar vertebra, which point was referred to by Albert in 1899, is located and a small piece of adhesive placed over this region. A line drawn from that point through the superior border of the symphysis pubis passes through the plane of the inlet of the pelvis. This method of locating the plane of the superior strait was described by Albert in his first article written in 1899 and has been used ever since by all workers whose methods have necessitated the locating of the plane of the superior strait.

The patient is placed in a semi-recumbent position (Fig. 7) with the pelvis centered over the cross lines on the surface of the Bucky diaphragm. By the use of calipers the distance from the adhesive tab to the Bucky is determined. By using a ruler the distance from the superior surface of the symphysis to the Bucky is measured. The patient is adjusted so that these two measurements correspond. This places the plane of the inlet in a position parallel to the film. For the correct location of the inner border of the superior point of the symphysis and the correct location of the sacral promontory, it is my opinion that this

is the correct position. Where the strait of the pelvis is not placed parallel to the film I believe that for the correct location of the sacral promontory, stereoscopic films should be taken.

The tube is now centered to correspond with the cross lines of the Bucky at a focal film distance of 30 inches. An exposure is made of the pelvis. The patient is then removed from the table and the lead scale placed in the same plane as the pelvic inlet. This is accomplished by using the measurements previously mentioned and with the Bucky running a short exposure is now made which superimposes the scale on the film.

If the patient is one with known deformed, generally contracted or just minor pelvis or if one wishes to vary the technique by not having the plane of the pelvis parallel to the film, the procedure then varies and stereoscopic roentgenograms are taken of the pelvis instead of a flat film. The scale in this latter instance is superimposed on one of the stereoscopic films. The reason for adopting this method is that the stereoscopic roentgenograms gives one a better visualization of the pelvic inlet, makes the parts desired to be measured more distinct and gives one a better localization of these points. This is a considerable help in cases as already mentioned.

The pelvimeter consists of a lead sheet approximately 16 by 19 inches in size. This sheet of lead is 1/16 of an inch thick and held firmly to a board of the same dimensions by screws placed around the border of the lead plate. The board is approximately 3/8 inch thick and made of basswood. Stiles are placed across each end of the board to prevent warping. Legs are mounted on the board and by the use of thumb screws the pelvimeter can be lowered or raised (Fig. 4).

On the surface of the lead sheet a line running in the longitudinal center of the plate intersects a transverse line at right angles at the center of the plate. By the use of a small sewing needle two holes ten centimeters apart were made in the former line and equidistant from the intersection with the latter line (Fig. 6). When an exposure of this scale is made on the film two small dots in the

region of the pelvic inlet are reproduced on the film (Fig 9)

In an article recently published Moore and Skinner proved that when a perforated lead plate such as Thoms uses is placed between the focal point of an X ray tube and a film, with the position of the lead plate parallel to the film the space between the dots reproduced on the film when an exposure is made will all be equally distorted and the space between the dots would be the same whether near the center of the film or near the periphery. Therefore the space between two dots 1 centimeter apart is distorted on the film the same amount regardless of where they appear on the film. Also the space between any two points 10 centimeters apart on the scale would be distorted on the film a proportionate and equal amount to all dots on a scale 10 centimeters apart. Then each centimeter of the 10 centimeter scale would be distorted an equal amount and would not necessarily have to be represented by a dot on the film. Therefore the two dots on the film represent the proportionate distortion for all measurements made on that particular film.

To complete the procedure then and make the measurements, it is only necessary to have a ruler that can be distorted in the same proportion that the two dots on the film are distorted. This has been accomplished by making a ruler out of flexible and uniform rubber. A normal centimeter scale 10 centimeters long is printed on the rubber ruler. A frame is constructed to hold firmly the rubber ruler one end of which is movable and can be extended to any desired distance and held in position by a thumb screw (Fig 10)

When it is desired to take measurements of the pelvic inlet on a certain film all that is necessary is to extend the ruler until the zero mark and the 10 centimeter mark are the same distance apart as the two dots on the film. Then one has an equally distorted ruler on which each centimeter is distorted an equal amount and the pelvic measurements can be made directly on the film as one would make measurements with a ruler (Fig 11)

The value of this procedure is in its simplicity as well as its accuracy. The fact that only two dots are necessary makes the construction of the pelvimeter very accurate and easy. The making of the pelvic measurements on the X ray films by the use of a ruler is certainly simplicity itself. In cephalometry the scale is superimposed in the same plane as the region of the head to be measured.

CONCLUSIONS

Accurate pelvimetry is a valuable diagnostic procedure in obstetrics.

Roentgen pelvimetry is gradually superseding manual and instrumental pelvimetry due chiefly to the fact that it is a much more accurate procedure.

There are many good methods of roentgen pelvimetry in use at the present time, many of which are simple and practical enough for the use of any obstetrician.

The value of roentgen pelvimetry as a diagnostic measure in obstetrics is dependent upon simple and practical methods in the hands of many rather than complicated procedures in the hands of a few.

Any good recognized method is accurate enough for all practical purposes.

Cephalometry is a valuable adjunct to pelvimetry in the study of disproportion in certain cases.

Recommended routine would be as follows:

1. Roentgen pelvimetry on all primiparae as soon as pregnancy is diagnosed.

2. Roentgen pelvimetry on all multiparae with history of difficult labors.

3. Routine care and diet by obstetrician in all cases where small pelvic inlets or distorted pelvis is found.

4. Roentgenogram of all obstetrical cases just prior to term.

5. If latter procedure shows any evidence of disproportion, cephalometry should be resorted to.

If this routine is adhered to there should be some manifest reduction in mortality in obstetrics.

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INTRARENAL AND PERIRENAL LIPOMATA

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LIPOMATA or fatty tissue tumors have well defined gross, microscopic and chemical characteristics. They are subject to secondary degenerative changes in advanced growth and are frequently found in combination with other connective tissues and are then classified as fibrolipomata, myxolipomata, chondrolipomata and so forth. The lipomata are of clinical significance because (1) the larger lipomata produce serious pressure effects on adjacent structures; (2) large lipomata have caused emaciation by diverting nutrition from the body (Wells); (3) multiple lipomata may occur a condition noted by Virchow in which hundreds of lipomata throughout the body are found in such organs as the lungs, liver and other tissues where fat normally is absent; and (4) sarcomatous transformation may appear and recurrence after removal is not infrequent and is sometimes evidence of this malignant change.

The etiology of these growths is unknown but various hypotheses have been advanced to explain their origin. The general etiological classification of lipoma and lipomatoid processes of Ewing is as follows: (1) obesity; (2) localized overgrowth of fat tissue as, for example, the so-called fatty neck or lipoma annulare colli; (3) replacement lipomatosis, seen in atrophic organs, for example, the kidney and lymph nodes; (4) homologous lipoma for example the solitary subcutaneous lipomata; (5) heterologous lipoma for example intrarenal lipoma; and (6) overgrowth lipomata consisting of the mixed tumors and teratomata. Other conditions which have been suggested as possible etiological factors are hereditary influences, congenital predisposition, disturbances in thyroid and pituitary glands, alcoholism, trauma, inflammation.

Heterologous lipomata may arise in the kidney as stated by Alsberg from misplaced groups of embryonal tissue cells from the fat capsule, which become enclosed in the parenchyma of the kidney in the process of development. Warthin, on the other hand, stated his belief that fatty metamorphosis occurs and that the lipomata arise from the connective tissue of the kidney by transformation of fibroblasts into fat cells.

Grawitz pointed out the existence of true intrarenal lipoma. He believed that they were rare

and he emphasized the importance of distinguishing them from the larger group of renal neoplasms with high fat content but which microscopically simulated suprarenal tissue. To this latter group he applied the term hypernephroma.

Intrarenal lipomata differ from pararenal lipomata by taking origin from tissue in which fat normally is absent. In the literature two varieties of intrarenal lipomata have been described the most common are small circumscribed single or multiple either pure or mixed, and less common is the so-called replacement lipomatosis form noted by Askarny. To our mind this type does not belong in the group of lipomata because it does not represent pure tumor but rather fatty replacement which in the kidney is associated with atrophy, infection and the formation of calculus. The same pathological process is observed in many other parenchymatous organs undergoing atrophic degenerative changes.

The perirenal lipomata take origin from the perinephric fat and contain as a rule more connective tissue. Areas with accumulation of mucinous fluid are often seen and sarcomatous change is not infrequent. Their growth, ordinarily slow, may progress rapidly with malignant change and recurrence after operative treatment is not unusual. As the perirenal lipoma advances in growth and attains large size, it encroaches on the peritoneal cavity by elevating the posterior parietal sheath, and is then classified simply as a retroperitoneal lipoma. The anatomical distinction from lipomata originating from adjacent adipose structures often being impossible.

REVIEW OF LITERATURE

The literature in general consists of single case reports or small series of cases. A few writers have published larger reviews of the subject. Von Wahldorff for example reviewed 165 cases of retroperitoneal lipoma of all types: 70 cases (46 per cent) were pure lipomata and 83 (54 per cent) were mixed. Of this latter group 31 (30 per cent) were fibrolipomata, 16 (10 per cent) myxolipomata, 15 (10 per cent) fibromyxolipomata, and in 21 (14 per cent) there was sarcomatous change.

Retroperitoneal lipoma occurred most commonly in the fourth decade, although one case was



Fig. 1. Specimen showing the cut surface

found in the first year of life and one in the eighth. One hundred six patients (72 per cent) were females and 42 (28 per cent) were males. In 132 cases in which the site was definitely recorded it was in the abdomen in 104 cases (79 per cent) and in the pelvis in 28 (21 per cent). From the pathologico-anatomical standpoint 30 cases (23 per cent) were limited to the capsule of the kidney and 46 cases (33 per cent) involved the perirenal and lumbar fat. In von Wahlen dorf's opinion the myxoma represents a transitional form between benign and malignant.

Albarran and Imbert in a total of 54 retroperitoneal tumors, found 22 lipomata, 6 lipomyxomata, 12 fibromyxolipomata, 1 myxoma and 17 with sarcomatous change. Adami recorded 42 cases of lipoma of the retroperitoneal tissue in general, a third of them originated around the kidneys.

Le Fur cited 122 cases, 110 of which had been reviewed by Thevenot and they overlap to some extent those reviewed by von Wahlen dorf. The remainder were additional cases reviewed by him since the war. Lecene in 33 cases found an incidence of 70 per cent in females and 30 per cent in males. The average age was from 40 to 50 years but there was 1 case in the first year and 1 in the seventh decade. The incidence of occurrence on both sides of the body was equal. Only in the smaller tumors could the point of origin be determined with any degree of certainty. In his series of 33 cases there were 6 lipomata, 4 fibrolipomata, 2 fibromyomata, 3 fibromyxomata, 5

fibrosarcomata, 2 angiosarcomata and two mixed tumors.

Ilansky in a study of the so-called replacement lipomatosis or renal atrophy with fat substitution found the total number of cases of perirenal lipomata reported in the literature as approximately 150. He quoted Lubarsch as saying that in the 40,000 necropsies at the Berlin Institute from 1897 to 1917 only one case of fatty tumor of the capsule of the kidney was seen.

Because of the rarity of this condition probably most of the cases encountered have been reported in literature but in many instances the origin of the tumor whether from the capsule of the kidney or from the perirenal fat is not stated. Flansky's case of diffuse fatty replacement of renal tissue is similar to those reported by Dick.



Fig. 2. Specimen showing attachment to the kidney



Fig. 3. Specimen showing capsule of tumor and the adult adipose tissue, the structure of which the tumor was mainly composed (low power)

mson, Warthin and others. Rokitsansky and Alsberg stated their belief that the condition is primary but the considerable degree of adhesions, the parenchymatous atrophy and the frequent association with renal calculi speak strongly in favor of an inflammatory basis. Warthin stated that most of the references to lipoma of the kidney found in the older literature do not deal with true lipoma, but with masses of fat surrounding an atrophied kidney, of which the dilated pelvis or ureter contained a calculus. Usually the kidney was completely surrounded by the tumor, hence the capsule was looked on as the origin of the growth. Crabtree stated that perirenal lipomata are more common than intrarenal, but this was not the experience of Hunt and Simon. The latter emphasized the point that perirenal



Fig. 4. Specimen showing an island of embryonic fat tissue (high power)



Fig. 5. Specimen showing intimate relation of base of tumor with renal cortex, complete absence of renal capsule may be noted (low power)

lipomata, if large, are likely to be of more clinical significance.

Smaller series of cases or reports of single cases of especial interest may be found in the papers of Barclay, Lacrampe, Esselsberg, Alsberg, Warthin, Reynolds and Wadsworth, Hirsch and Wells, Alexander, Samuels, Lower and Belcher and Crabtree.

Most writers agree that the diagnosis of these tumors is difficult. Symptoms are absent or obscure until the enlargement is sufficient to produce disturbance in adjacent organs by compression. Hence, delay in recognition is usual. The earliest symptoms noted in the literature, when the gastro-intestinal tract has been compressed, have been primarily vague dyspepsia with dull pain in the back, heaviness after meals, vomiting



Fig. 6. Specimen showing the large blood vessels in the region of the renal cortex (low power)

diarrhoea, constipation, and in some instances chronic or acute ileus. Pressure on the kidney of the pelvis and ureter have produced hydronephrosis pyelitis oliguria, or anuria. The more general symptoms noted were weakness, fatigue, nervousness, and inanition without definite cause. On the objective side, the discovery of an abdominal mass, occupying the retroperitoneal lumbar region is the most significant single observation. Whether such physical method as palpation percussion and auscultation of the large bowel can be depended on to define the situation of the lesion is open to question. Urological methods should always be invoked in order to implicate or exclude the genito-urinary tract. Exploratory laparotomy should be advised whenever such a tumor is suspected as the condition is essentially surgical and the diagnosis is rarely made before operation. It is as de Quervain has said: "Jeder Regel spotten die Geschwulste der Nierenfettkapsel."

The earliest case of retroperitoneal lipoma in which operation was performed was reported by Lizars in 1824. The treatment is surgical and should be as early and as complete as possible. The choice of surgical approach depends chiefly on the size of the tumor; most authors prefer the lumbar route for the smaller tumors because of its lower mortality, and the abdominal route for the larger tumors because of the increased accessibility. Nephrectomy is indicated whenever the kidney is intimately adherent to the tumor. Nephrectomy was required in 138 operations (29), 29.7 per cent. Hartman and Leone performed nephrectomy in 18 of 27 cases and de Chamoff removed the kidney in 14 of 46 cases. Extirpation of the tumor by morcellation is occasionally the only means possible but should be avoided when possible because of the danger of spreading tumor cells of infection and of hemorrhage. Drainage usually is advocated because of the extensive raw surface left after ablation of large tumors.

In von Wahlendorf's series of 165 cases 113 came to operation. Twenty-nine patients died during or at the conclusion of the operation, a mortality of 25 per cent. Twenty-one (14 per cent) of the growths were sarcomatous, and 20 per cent of the remainder were considered borderline between benign and malignant. In 60 cases (54 per cent) cure was obtained. Nine patients could not be traced. Albarran and Imbert reported a mortality of 30 per cent in their 54 cases, and Thevenot, in his 110 cases a mortality of 23 per cent, whereas Le Fur on adding his 12 cases to those of Thevenot, obtained the slightly higher figure of 25 per cent. Recurrence was fairly com-

mon. Von Wahlendorf noted recurrence in 15 cases, 14 per cent of his 113 operative cases. In 3 of Le Fur's cases there was recurrence, both local and general in 2. In each instance in the latter the pathologist had made an unqualified diagnosis of benign lipoma. Consequently Le Fur prefers to consider all pararenal tumors as malignant and to extirpate as widely as possible in order to diminish the risk of recurrence.

From summarizing the literature we conclude (1) the etiology is unknown, (2) the condition is more common among women, (3) the diagnosis is difficult and before operation almost impossible, (4) the treatment is surgical, (5) the operative mortality is fairly high, and (6) malignant change and recurrence are fairly common.

REVIEW OF DATA CONCERNING CASES IN THE MAYO CLINIC

At The Mayo Clinic, Masson and Horgan reported 12 cases of retroperitoneal lipomata. Mayo and Dixon and Hunt and Simon reported 3 cases and 2 cases respectively.

We reviewed the 314 case records of retroperitoneal tumors observed in the clinic between the years 1910 and 1930 and in 42 of these retroperitoneal lipomata were recorded. Forty tumors were extrarenal and 2 were intrarenal. Nineteen patients were men and 23 were women. The youngest was aged 28 years and the oldest 68. The average age was 49.3 years. The average duration of symptoms was 5.8 years, the shortest being 3 weeks and the longest 20 years. A diagnosis of retroperitoneal tumor was suggested in only 5 cases. In 21 cases the pre-operative diagnosis was incorrect and in 14 the patient came to operation with a diagnosis of unclassified abdominal tumor. In 2 cases a diagnosis was based on a pathological report made subsequent to operation elsewhere.

The complaint of enlarging abdomen or the discovery of a mass by the patient was most common and occurred in 28 of the 42 cases. Abdominal pain or discomfort was noted in 20 cases, dyspepsia in 11, loss of weight, strength, and appetite in 11, constipation or diarrhoea in 8, nausea and vomiting in 4, and swollen testis in 1 case. Examination disclosed a palpable mass in all but 1 case. In 7 cases the mass was on the right side and in 14 it was on the left. In 5 cases the entire abdomen seemed filled with the tumor and in 2 the mass was in the umbilical region. The upper part of the abdomen was involved by a mass in 1 case, and the lower part in 2 cases. There was little of diagnostic import in the laboratory data. Urological examination was made in 12 cases.

In 9 cases the mass was diagnosed as extrarenal. In 3 cases the diagnosis of renal tumor was made correctly and in 1 case the diagnosis of renal tumor was disproved at operation.

In all but 4 cases a transperitoneal approach was employed. In these 4 the usual incision in the loin for nephrectomy was used. Nephrectomy was performed six times. At operation the situation and attachments of these tumors were found to be as follows: in the right upper quadrant in 1 case, in the right side in 4 cases, in the right renal fossa in 7 cases, in the left upper quadrant in 1 case, in the left lower quadrant in 2 cases, in the left side in 5 cases, in the left renal fossa in 11 cases, in the entire abdomen in 2 cases, in the upper part of the abdomen in 1 case, in the lower part of the abdomen in 1 case, in the mesentery of the small or large bowel in 9 cases, in the pelvis in 3 cases, in the right kidney in 1 case and in the left kidney in 1 case. In 21 cases the tumor was thought to have been removed in its entirety and in 13 it was possible to remove a portion only. In 9 cases a small piece of tissue was taken for diagnosis.

The largest specimen removed was a fibromyxolipoma which weighed 47 pounds. In 35 cases the tumor was single and in 7 the tumors were multiple. The total number of tumors reported on was 61. Of these there were 21 lipomata, 6 fibrolipomata, 4 myxolipomata, 7 fibromyxolipomata, 1 myxoliposarcoma, 4 fibromyxoliposarcomata, 1 fibroliposarcoma, and 11 lipomata with sarcomatous change. Therefore 44 were apparently benign and 17 were definitely malignant. Infection or degenerative changes appeared in nine of the lipomata.

Of the 43 patients, 8 are living and well, the shortest 9 months and the longest 4 years since operation (average 2.3 years). Two other patients are living but have had a recurrence of symptoms 2 and 4 years after operation. Eight patients died in the hospital, 4 of bronchopneumonia, 2 of peritonitis, and 2 of shock and hemorrhage. Seventeen patients have died since operation, varying from 2 months to 4.5 years, and 7 could not be traced. Of 8 patients whose condition was malignant at the time of operation, 6 are known to be dead, 1 patient is living and well 5 months after operation, and 1 could not be traced. Twelve patients had recurrence. Six of these had manifested malignant change at the first operation and of these 5 are dead and 1 is living 10 months later. Six patients had recurrences there had been no evidence of malignant change at the first operation, and of these 5 are dead and 1 is living 3 years later. One of these patients was

operated on four times and one three times for recurrence.

In addition there were 14 cases in which intrarenal lipomata were found at postmortem examinations. These growths usually were small, cortical or subcapsular fatty nodules of no clinical significance.

Comparison of our data with those in the literature shows in general fairly close agreement. It will be noted that the condition is more common among women, that the diagnosis is seldom made before operation, that operative mortality is high (19 per cent in our series) and that recurrence is fairly common (14 per cent in our series of benign lipomata and a total of 28.5 per cent in cases showing malignant change at the time of the first operation).

The following report of a case is of interest because of the pararenal anatomical position of the growth and its probable intrarenal origin.

A woman, aged 36 years, came to The Mayo Clinic September 14, 1931, complaining of intermittent attacks of diarrhea, occasionally with generalized abdominal cramps, of 1 year's duration. The attacks occurred about once a month and lasted 1 or 2 days. Blood or mucus had not been noted in the stools. Her general health otherwise was good. The appendix and a cystic right ovary had been removed elsewhere, and splenectomy had been advised.

General examination was essentially negative, except for a tumor in the left upper quadrant of the abdomen. The mass, although not altogether typical of a spleen, still had more characteristics of an enlarged spleen than of a kidney or a retroperitoneal tumor. Urinalysis was negative. The concentration of hemoglobin was 72 per cent, erythrocytes numbered 4,510,000, and leucocytes 8,500 in each cubic millimeter of blood. The patient pretested intravenous urograms made elsewhere which apparently excluded the kidneys.

A diagnosis of tumor of the left side of the abdomen was made, with splenomegaly as the most probable pathological condition and retroperitoneal tumor as the second. September 25, 1931, the patient was operated on through a left rectus incision. A large retroperitoneal tumor was encountered. When the posterior sheath of the peritoneum was opened the tumor was brought into view. It was definitely encapsulated, about 25 to 30 centimeters in diameter, fairly movable, irregularly oval, and yellowish. The mass separated readily with minimal bleeding from adjacent structures except at its attachment in the lower pole of the left kidney. Here, because of its firm attachment to the kidney, it was deemed best to remove the tip of the lower pole of the kidney with the tumor. On palpation of the vessels in the pedicle of the kidney, it seemed as if the blood supply were greater than usual. The retroperitoneal space was then drained through a separate incision in the left loin. General abdominal exploration gave negative results. The patient had an uneventful convalescence and was dismissed from the clinic October 15, 1931 in good general condition.

The pathologist described the specimen as a pure retroperitoneal lipoma weighing 850 grams and measuring 15 by 11 by 12 centimeters, with a small portion of the kidney. Grossly the tumor was a smooth, soft, light yellow ovoid encapsulated body. Cut section revealed very little fibrous

tissue and no large blood vessels (Fig. 1). At its upper end it was attached to the tip of the lower pole of the kidney (Fig. 2). The renal capsule stripped freely except at this point of attachment. Several sections were cut from this site and stained with hematoxylin and eosin for microscopic study. Sections were also taken from other portions of the tumor. These showed that the tumor was composed mainly of adult adipose connective tissue (Fig. 3) with here and there small islands of cells having a stainable cytoplasm, small, densely stained nuclei, and a variable number of lipid droplets (Fig. 4). These cells conformed in morphology and staining reactions with embryonic types of fat cells. Connective tissue was scanty and when present was arranged around blood vessels. In the sections taken through the site of the attachment of kidney to tumor the areas suggesting embryonic fat cells were more numerous (Fig. 5) but the most striking feature was the presence of large blood vessel in the tumor adjacent to the parenchyma of the kidney (Fig. 6), strongly confirming the supposition that at least a goodly portion of the blood supply to the tumor came directly from the blood vessels of the renal cortex. The tumor was also in direct continuity with the cells of the renal cortex, the capsule at this point being absent and on the margin being reflected up over the tumor. These facts lead us to conclude that we were dealing with a true intrarenal lipoma. In spite of its gross anatomical paranrenal situation.

In the interest of accurate pathological classification we suggest that tumors of this type shall be subjected to careful histological study. It is possible that some of the cases in the literature reported as perirenal lipoma are actually, as in this case intrarenal at least in origin. In this connection the observation of increased vascularity of the renal pedicle made at the time of operation is of particular interest.

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THE ADMINISTRATION OF PROCTOCLYSTERS

GEORGE L. PERUSSE, JR., M.S. M.D. CHICAGO

REQUESTS have been made from time to time for information as to the best methods for the administration of proctoclysters. It would seem that of all hospital procedures designed to aid the patients in a time of acute need, this is the most slighted and neglected. John B. Murphy in his dissertation on peritonitis in 1908 describes a method of administering fluids per rectum which cannot be improved upon to this day. Some difference of opinion may be expressed on the duration of such administrations of fluids as well as in the choice of fluid used but the procedure is certainly excellent. We are all familiar with the sight which greets us on entering the room of the patient receiving proctoclysis. There is the vacuum flask perched on the uppermost rung of a stand with fluid running into the patient 40 to 60 drops a minute, without the slightest regard as to whether the patient is absorbing the fluid at the rate at which the drip is set. Soon we see that the patient has soiled his linen and is complaining of great distress. The nurse complains that nothing can be done with the patient. (A glance on the inside of the tube would probably show that the pressure was 15 to 15 inches of water pressure.) The attending surgeon then loses patience with the method and orders hypodermoclysis. Allow me to quote an excerpt from Murphy's original paper on the subject. "The fluid should be administered through a fountain syringe to which is attached a three-eighths inch rubber hose fitted with a hard rubber or glass vaginal douche tip with multiple openings. This tube should be flexed to almost right angles 3 inches from its tip. A straight tube must not be used as the tip produces pressure on the posterior wall of the rectum when the patient is in Fowler's position. The tube is inserted into the rectum to the flexion angle and secured in place by adhesive strips binding it to the side of the thigh so that it cannot come out. The rubber tubing is passed under the bedding to the head or foot of the bed, to which the fountain is attached. It should be suspended from 6 to 14 inches above the level of the buttocks and raised or lowered to just overbalance hydrostatically the intra-abdominal pressure, i.e. It must be just high enough to require 40 to 60 minutes for $1\frac{3}{4}$ pints to flow in, the usual quantity given every 2 hours. The flow must be controlled by gravity alone and

never by a forceps or constriction on the tube, so that when the patient endeavors to void flatus or strains, the fluid can rapidly flow back into the can, otherwise it will be discharged into the bed. It is this ease of flow to and from the bowel that insures against overdistention and expulsion onto the linen. The fountain had better be a glass or graded can so that the flow can be estimated. The temperature of the water in the fountain can be maintained at 100 degrees by incasement in hot water bags (or by partial immersion of an electric light globe). The fountain is refilled every 2 hours with $1\frac{3}{4}$ to 2 pints of solution. The tube should not be removed from the rectum for 2 or 3 days. When the nurse complains that the solution is not being retained, it is certain that it is not being properly given even children retain proctoclysis surprisingly well.

McClanahan in his modification of Murphy's method, uses merely an irrigating can and a rectal tube with the end cut off. The can rests on a table beside the patient's bed which is on a level with the patient's rectum. Care is taken that the level of the fluid in the can is at no time more than 4 inches above the level of the rectum. The rectal tube extends from the can, under the bed clothes into the patient's rectum. It is not necessary to regulate the flow because a constant to and fro movement is maintained between the bowel and the can.

The great disadvantage to any arrangement such as Murphy and McClanahan describe is that the nurse is required to maintain the fluid level of the solution used, to obtain the best results. It cannot be too strongly stressed that herein lies the success or failure of proctoclysis in any given case.

Recently there has appeared on the market a clyster can with a vacuum container and a visualizer tube on the outside, which enables one to see the level of the fluid within the reservoir. It is the writer's practice to suspend this device at such a height that the visible level of the fluid in the can is about 4 to 8 inches above the patient's rectum. The clyster can is suspended from a stand which may be raised or lowered by means of a crank. Every half hour or so the can is raised to maintain the original pressure if the patient is absorbing the fluid readily.

The preliminary treatment to proctoclysis must always include a thorough emptying of the

bowel by means of an enema. This is done practically routinely in all the hospitals as a pre-operative measure.

The introduction of fluid within the bowel is accomplished by means of the largest size catheter possible to obtain which is pushed about 6 inches within the anal ring. The fluid of choice is a 1 per cent glucose solution which is very readily absorbed and non irritant.

The maintenance of the temperature of the clyster solution is not of the greatest importance in this type of administration of fluids because the amount of fresh fluid introduced into the bowel at any one time is very small. Thus even at a rate of flow of 10 cubic centimeters per minute into an original volume in the bowel of 200 to 300 cubic centimeters the temperature change is small. However the solution must be at body temperature when first administered.

The clysis is run in 4 hour periods with a 2 hour rest period in between. At the end of the 2 hour rest period following two courses of clysis it is customary to give the patient a 1-3 enema for cleansing purposes. Thus accumulated fecal material and flatus which has not been expelled through the solution may be removed. Such administration of fluid may be carried on indefinitely without the slightest distress to patient.

We have observed from time to time that the fluid does not readily enter the rectum at the beginning of the procedure. The difficulty may be overcome by lowering and raising the reservoir 15 to 25 inches above the level of the rectum several times. The increased pressure causes the walls of the bowel to fall away from their close approximation. The can is then set at the level at which the fluid just begins to flow into the bowel (4 to 8 inches).

If it is necessary to make use of the type of vacuum bottle which employs a drip visualizer, the midpoint of the latter may be set at the required height above the rectum and the level observed when the tube is filled, may be maintained. If desired a very simple device may be employed which gives excellent results. A glass percolator may be used for the actual administration of the clyster and the vacuum bottle with the drip visualizer may be utilized to maintain the level in the former. The end of the tube from the visualizer is run under the surface of the fluid in the percolator so that warm solution is constantly coming in. The opening in the top of the percolator may be lightly wadded with cotton, and the level of the fluid is maintained at 4 to 8 inches above that of the rectum.

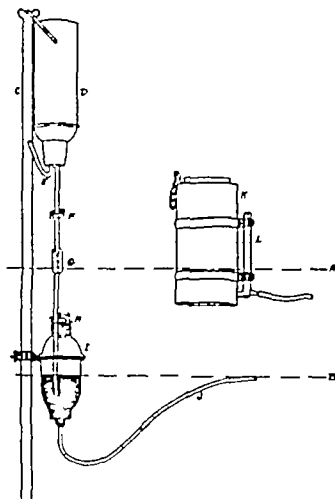


Fig. 1. The line A indicates the level at which fluid must be maintained in the reservoirs D or K, when either of these is used alone. This level is 4 to 8 inches above the patient's rectum. The line B indicates the level of the fluid in apparatus I when used in connection with D. C is the stand, L an air vent, F a screw clamp, G a drop visualizer, H cotton wadding, J tube to patient's anus, I visualizer tube of K. The level in I is also 4 to 8 inches above the rectum.

The following rules governing the use of proctoclysis are suggested:

1. Be sure that the pressure employed is just sufficient to overcome the intra abdominal pressure (4 to 8 inches).
2. Be sure that the solution used is non-irritant and readily absorbed. (A 1 per cent glucose solution is excellent for the purpose.)
3. Be sure that the patient's bowel is cleansed at regular intervals.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1933

THE CLINICAL AS DISTINGUISHED FROM THE LABORATORY EVALUA TION OF FACTORS INVOLVED IN HEALING OF INFECTED WOUNDS

IN his book, *Medical Education* Dr Abraham Flexner directs our attention to the fact that there is a science of medical practice no less important than the science of the laboratory. This comment appears to apply especially to the treatment of infected wounds. Lessons learned from practice have quite generally been set aside in such cases while technical laboratory methods difficult of clinical application have been brought to the bedside. A field in which this change has given many poor results is that of compound fractures. We are fully aware that reduction of the fracture accurate maintenance of length and position and immobilization are essential to good results. In all of the customary antiseptic methods, however plaster-of-paris casts are barred and splints are disturbed or removed in order that irrigations, fomentations, and such measures may be carried on.

In 1616 Cesare Magati of Scandia published his celebrated work *de Rara Medicatione* in advocacy of an infrequent dressing program for wounds. Magati lacked only the knowledge of infectious organisms and of the modern skeletal fixation devices and plaster of paris for the protection of the wound and the patient to lead him to the position that we are reaching only today.

Belloste, a French military surgeon adopted the teaching of Magati and gave him full credit (contrary to an Italian notion) for his contribution to surgical practice. John Hunter in speaking of compound fractures, said a variety of inventions have been employed to prevent the motion" (of the fragments) "but the dressing of the wound every day counteracts the effect of every invention that has been thought of and it is perhaps impossible to dress the sore without motion.

Lister's application to surgery of the germ theory of Pasteur was first designed only to exclude infection from the wound. The original Listerian idea was soon changed to a plan of treatment calculated to combat the organisms in the wound. This altered antiseptic program, the many variations of which have had their origin usually in the laboratory has led us from one excess of antiseptic activity to another until it culminated finally in the Carrel Dakin method during the war and now in the "viable antiseptic" or maggot treatment. All of these antiseptic methods are open to the objections that they expose healing wounds to trauma and infection, that they disturb traction and immobilizing apparatus which are necessary for all inflamed and injured parts, and that they disregard all

fundamental rules of practice regarding drainage rest, and protection of the wound and the patient

During the past ten years a different "method of management" has come to be widely employed a method in which infrequent dressings have been systematically combined with adequate drainage with protection of the wound surface against re infection injury by instruments drainage tubes or chemicals and with prolonged immobilization of inflamed or injured parts in plaster-of-paris casts

Statistics have now accumulated to show that by this mode of treatment in osteomyelitis, compound fractures and other infected wounds rapid and sound healing is obtained in a high percentage of cases There is a great reduction in suffering for patients and substantial economies are effected in labor and hospital costs Patients leave the hospital in a few days and dressings are done at intervals of weeks or even months instead of daily or oftener as heretofore

The operative and dressing technique are designed for adequate drainage and the protection of the wound surface by means of a non absorbent non irritating pack with the wound left wide open No drainage tubes, stitches, or chemicals are employed in the wound, and no postoperative dressings are done for several weeks so that healing may be well established before the wound or the injured or inflamed parts are disturbed in any way

This, it will be seen is a clinical rather than a laboratory program. Tests of chemical agents counts of organisms and their reaction upon each other are disregarded Inspection and explorations of the wound and the wound area are specifically precluded by the closed cast and entire reliance is placed upon the symptoms of pain swelling temperature

leucocytosis, and general appearance of the patient either for satisfaction as to patient's progress or for warnings of complications

Some laboratory studies already made suggest that alterations in virulence of the organisms after long intervals without change of dressings the presence of bacteriophage, or the purely physical effect of the petrolatum dressing medium may be of interest in connection with the healing of these wounds From the purely clinical point of view, however it appears that the program of protecting the patient by minimal surgical procedures by guarding the wound surface against trauma chemical irritants and infection, and by immobilizing the nervous and vascular parts as well as the bones and joints in correct position for immediate as well as ultimate function may be the important factors that conduce to recovery That is, the patient is placed in the best position and the injured and inflamed parts are surrounded by the most favorable conditions for the patient to set up and employ his own processes of repair What happens in the wound and under the dressing therefore is of secondary importance to the patient though it may be of great academic and scientific interest to the laboratory technician and the surgeon The principal forces of clinical scientific interest and of greatest importance to the patient are those operating within himself, and these probably supply all of the active healing agents and principles that appear in and about the wound

It is a maxim among clinicians that in diagnosis the laboratory and other instrumentalities do not establish but simply serve to confirm the clinical impressions Perhaps we should reclaim this point of view for therapy, making sure that the laboratory point of view remains subservient and ancillary to the clinical Such at least, appears to

be the lesson which we have learned in the treatment of infected wounds

H. WENNETT ORR.

PROGRESS AND PROSPECTS OF ROENTGENOLOGIC DIAGNOSIS IN RELATION TO SURGERY AND CLINICAL MEDICINE

LATE in 1895 came Roentgen's announcement of his discovery of roentgen rays, which brought to vision an aid scarcely second to that afforded by the microscope. Then began a stupendous advance in the diagnosis and treatment of disease of man.

At the outset, employment of the roentgen rays in medicine was a separate and special art. Roentgenological examination, with its savor of mechanics, was somewhat beneath the dignity of physicians of the old school and its early applications were relegated to lay tinkers with electricity or photography and to a few physicians who found pleasure in the study of electric and actinic phenomena. These men were the first roentgenologists. But soon every physician was imbued with the desire to make use of this diagnostic agent which, from all accounts, must be simple to use and probably capable of exhibiting the internal structures of the body as clearly as the furniture in a room can be seen through an open door. Thousands of physicians installed roentgenological equipment. Disillusionment followed speedily. Generating apparatus was capricious, and vacuum tubes were temperamental. To produce a roentgenogram a tediously long exposure was required. Roentgenograms were disappointing, scarcely more than the outline of the bones could be seen. Internal organs and soft tissues cast a confused aggregation of shadows which defied separate identification.

Apparently the game was not worth the candle, and most machines were consigned to

the attic. Thus, roentgenology was handed back to its pioneers, who continued faithfully to carry on. Today their names stand out vividly on the medical roster.

About 1910 the efforts of these pioneers began to yield conspicuous results. The medical world awoke to the realization that the roentgen rays were good for something more than to disclose the presence of fractures and foreign bodies. From that period on roentgenological diagnosis bounded forward. Now whatever the diagnostic problem may be, roentgenological examination is almost certain to be invoked for its forthright solution, for confirmation of the clinical opinion, or for the revelation or exclusion of hidden complications. Withal let it be noted well that with few exceptions the achievements and capabilities of roentgenology are due to the efforts of men who have applied themselves persistently and solely to this line of endeavor—roentgenologists.

In view of its progress in the past, there would seem to be little reason for concern as to the future prospects of roentgenology. Nevertheless, most of its practitioners, including those who are not apprehensive as to their personal welfare, regard the general outlook with anxiety for they are doubtful that the integrity and efficiency of roentgenology will be maintained. In too many instances the roentgenologist apparently is still regarded as a supertechnician rather than as a medical consultant. Too often his work, both technical and interpretive, is subjected to irksome supervision by his clinical and surgical associates. From every quarter he sees invasion of the roentgenological field threatening partition of its domain. Many surgeons, clinicians, and specialists prefer to employ roentgen rays directly or make their own interpretations, or entrust technicians with diagnostic responsibility even when competent roent-

genologists who could render better diagnostic service are at hand. As a further affront many young but thoroughly trained roentgenologists are driven by circumstances to accept full time employment at an extremely modest salary in certain open hospitals which appropriate all profits from the department although professional opinion now effectually bars similar employment of a surgeon, internist or otolaryngologist. Moreover by permitting any such practice in the roentgenological department, other specialists may be preparing a like future for themselves.

If it be granted that the foregoing conditions are widely prevalent non roentgenologists would perhaps offer the following pleas in justification. Roentgenology is not properly a specialty, for it covers virtually the entire field of medicine. To practice it efficiently the roentgenologist would need to be a universal specialist. Its foundations are not only too broad but also too shallow. Roentgenological data alone are not sufficient for diagnosis but must be construed in the light of the clinical facts. With his superior knowledge of these facts, the clinician has an advantage in interpretation. In essence roentgenological diagnosis is not analytic and rational but empiric and pictorial. Its fundamentals are simple, standardized, widely published and readily available to all. If equipped with a knowledge of them or with merely an atlas, the clinician should not require expert assistance in diagnosis. In short the roentgenologist is a superfluous intermediary, for no one can gainsay the right of any physician to use roentgen rays, and he should learn to employ them just as he has learned to use other means to aid his vision.

To all such claims the roentgenologist would oppose an emphatic dissent and might argue as follows. Roentgenology represents a logical division of labor in the evolution and higher

organization of medical science and art. It has the same tripartite foundation that underlies all medicine and all specialties in medicine, namely, anatomy, physiology, and pathology. A thorough understanding of these basic sciences as related to roentgenological phenomena is indispensable. Its efficient practice necessitates instruction and experience at least equivalent to those required for the practice of any other specialty. It is not true that clinical data enter primarily and inevitably into roentgenological interpretation, nor is it true that advance acquaintance with the clinical facts in a given case will assist the roentgenologist in the discovery or exclusion of disease. On the contrary, his prime task is a study of anatomy, physiology, and gross pathology as depicted by shadows and shadow-defects regardless of symptoms and physical signs. His study is not merely pictorial and comparative but highly analytic, and roentgenological advancement has been achieved almost exclusively by this method. Through repeated humiliations he has learned that foreknowledge of clinical facts will bias his judgment and lead him too often into error. In this factor he sees an insuperable obstacle to reliable roentgenological diagnosis by the clinician, and he holds it accountable for a large proportion of current mistakes. He freely admits that clinical facts are often necessary for differential diagnosis but in such instances he is confident that the best results will follow a review of their respective data by the roentgenologist and clinician in personal conference. For these reasons the roentgenologist feels strongly that to distribute his province among other specialties would be atavistic, degenerative, and a futile repetition of history.

Thus the issue is joined, an issue without rancor or bitterness but none the less an issue. It must be and will be settled without regard for the dignity, fame, or emolument of any

person group or guild for the spirit of trade-unionism has no place in it. It would doubtless determine itself in the natural evolution of medicine. If roentgenologists have been remiss in acquiring and maintaining the proficiency rightfully expected of them, if realities are lagging too far behind ideals, or if competent roentgenological diagnosticians are still too few the condition should be corrected. But whether a proper settlement shall be for-

warded or retarded depends not only on the roentgenologists but also on the attitude of the profession of which they are a part. The fact that an issue exists at all is conclusive proof that neither group fully understands the other and a program of mutual enlightenment should be inaugurated. This done, holding fast to the high purpose of all medical endeavor a fair and final solution will be well on its way.

B. R. KIRKLEY



DANIEL BRAINARD
1812-1866

MASTER SURGEONS OF AMERICA

DANIEL BRAINARD

THE first great surgeon of Chicago and the northwest was Daniel Brainard. Brainard was born in 1811 in the state of New York where he received his early education. He graduated at Jefferson Medical College in 1834. He settled in Chicago in 1836 when it was a town of about 5,000 people. He had great confidence in the future of Chicago and the west and believed that they would become great and prosperous communities. He believed that such a future demanded the development of schools and colleges and professional schools and as early as 1837 he secured a charter for a medical school which he named after Benjamin Rush, a signer of the Declaration of Independence and the father of American medicine. He went to Paris, which was then the center of medical education, in 1839 and remained until 1841 doing post graduate work. He then returned to Chicago and organized Rush College which began to give medical courses in 1843.

Daniel Brainard began his medical career just before or at the very beginning of the period which is usually recognized as the period of modern medicine, the date of which is approximately 1850. In order to visualize this period let us recall the prominent medical figures of that time. Paris was generally regarded as the center of medical education. Here Claude Bernard (1813-1878) was teaching physiology and medicine. Cruveillier was teaching pathology and creating his great atlases of pathology. Armand Trousseau, one of the greatest clinical teachers, was giving his wonderful clinics in medicine. Larrey, Napoleon's great military surgeon, was still living. Brainard's teachers of surgery were the great French surgeons Velpeau 1795-1867, Malgaigne 1806-1865, Nélaton 1807-1873. In England the great clinicians in medicine, Graves 1796-1853, Stokes 1804-1878, Bright 1789-1854, Addison 1793-1860, and Hodgkin were at work advancing medical knowledge and making medical history. In surgery, James Syme 1799-1870, William Ferguson 1808-1877, Sir Benjamin Brodie 1783-1862, Sir James Paget 1814-1899, were the leaders of British surgery of Brainard's time. In Germany Bernhard Von Langenbeck 1810-1887 and Gustav Simon were the great teachers of surgery, and in Russia Pirogoff, the great military surgeon was the recognized leading surgical teacher and one of the most prominent figures in Russian medical history.

Charles T. Parkes, Nicholas Senn, John B. Murphy and others—and Brainard's old clinic has continued to grow stronger and stronger with the passing years and with the great development that has taken place in anatomy, physiology and pathology which still continue to form the foundation on which the clinic is built.

Daniel Brainard founded a surgical clinic that has become an important factor in American surgery. One of its functions which has become a tradition in the clinic is the training of younger men to become teachers of surgery. In this it has been successful as shown by the fact that a number of the most important surgical chairs in this country are now filled with men trained in the clinic which Brainard founded.

We can obtain a good idea of the estimate of Brainard's work by the men who shortly succeeded him from an address delivered by Nicholas Senn when he assumed the professorship of surgery founded by Brainard. He said: Brainard, the founder of this institution and the first occupant of the chair of surgery, was a great surgeon, a gifted teacher and an original investigator. His giant intellect was not content in acquiring, practising and teaching what was known at his time, but sought new fields for exploration and the knowledge thus gained was freely infused into his students. Brainard's work in the field of experimental surgery brought him an international fame. His work left numerous permanent impressions on surgical literature; it created a stimulus which took possession of students and progressive surgeons throughout the world, leading them into new and unexplored territories.

ARTHUR DEAN BEVAN

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE book on *Orthopaedic Surgery*¹ by Walter Mercer is an elaboration of lectures and clinics on orthopaedic subjects conducted by the author at the University of Edinburgh the Edinburgh Royal Infirmary and other hospitals. The writer is associated with Prof. or John Fraser who has written the foreword. There are eighteen well arranged chapters covering about seven hundred pages.

The introductory chapter covers the history, definition and scope of orthopaedic surgery and briefly discusses the routine examination in an orthopaedic case and the technique of plaster of parts work. A concise chapter on congenital deformities follows. The next chapter on general affections of the skeleton includes nutritional and glandular disturbances. Referring to generalized osteitis fibrosa cystica the author discusses briefly the recent work on associated lesions of the parathyroid glands. Quoting Turnbull he states that the nature of the parathyroid enlargement is never neoplastic but that histologically the gland presents the picture of functional overactivity. The author describes Fraser's classification of primary bone tumors dividing them into simple border line malignant and tumors of unknown origin. Metastatic tumors and inflammatory conditions are omitted.

A chapter is devoted to tuberculosis of bones another to tuberculosis of joints and another to non tuberculous infections of joints due to specific infections such as pyogenic pneumococcal and gonococcal arthritis and Charcot's disease.

Chronic arthritis is described under two main types without adding further confusion to the numerous and frequently confusing classifications presented in recent literature.

Chapters on epiphyseal affections of the spine shoulder knee and foot contain comprehensive descriptions. The chapters on complications of trauma and affections of soft tissues emphasize the advantage of the general surgical training of the author.

The bibliography is copious and explicit being arranged according to chapters and affections described.

The book is concisely and systematically written and generally well illustrated although some of the roentgenograms could have been better chosen. The line drawings (done by the author's wife) accomplish the purpose for which they are intended although

done by one who evidently does this work as an avocation. Future editions may refer to Morrison's blip treatment of osteomyelitis the work of Crowe Hadjapoulos Burbank and others in the vaccine treatment of arthritis and Galeazzi in the treatment of scoliosis. In discussing recurrent dislocation of the shoulder Nicola's operation should be included. However one cannot expect everything to be included in such a concise volume. The merits of this book warrant its addition to the libraries of students practitioners and orthopaedic surgeons.

DANIEL H. LEVINTHAL

IN this interesting volume on surgery of the stomach and duodenum² Rheaume endeavors to present the operative procedures as practiced in North America in connection with the diseases of these organs. The first four chapters are devoted to the evolution of gastric surgery anaesthesia topographic anatomy and the pre-operative treatment. The remaining twelve chapters describe in detail typical procedures upon the stomach and duodenum.

The contributions of the American surgeons are given a prominent place. The operative procedures are illustrated with drawings frequently borrowed from well known sources such as the Mayos, Balfour Coffey and others. Each chapter is supplemented with a small but well chosen bibliographic index in which the names of American surgeons predominate. The entire subject matter is admirably presented and will no doubt stimulate much interest among the continental French surgeons.

GEORGE HALPERIN

THE first edition of this work³ (1911) by the present professor of anatomy at McGill University was prepared from lectures given to candidates for the Oxford diploma of ophthalmology. The lectures were illustrated with dissections and numerous photographs of these add greatly to the value of the book, which is the only extensive treatment of the subject in English. The 1932 edition contains 19 additional illustrations, chiefly of dissections and 39 pages of additional text. No chapters have been added the additions being made necessary by 190 contributions to the literature during the past 10 years which required consideration in the book.

¹TECHNIQUE CHIRURGICALE ESTOMAC ET DUODENUM. By Pierre RHEAUME. Paris, Masson et Co 1932.

²THE ANATOMY OF THE HUMAN ORBIT AND ACCESSORY ORGANS OF VISION. By S. Ernest WHEATall, M.A., M.D., F.R.C.S. (Oxon.) M.R.C.S. L.R.C.P. (Lond.) 2d ed. New York and London: Oxford University Press, 1932.

³ORTHOPAEDIC SURGERY. By Walter Mercer M.B., Ch.B. F.R.C.S. (Edn.) F.R.S. (Edn.). With a foreword by John Fraser M.C., M.D., Ch.M., F.R.C.S. London: Edward Arnold & Co., 1932.

About one-fourth of the book is devoted to the bony orbit and its relation to the accessory sinuses, a third to the eyebrows, lids, conjunctiva and lacrymal apparatus and the remainder to the globe extra-ocular muscles, nerves and cerebral pathways. Not only is the normal anatomy of the parts considered, but their development, common anomalies, and the normal changes which occur during life. We are reminded, for instance, that the roof of the orbit varies from 1 to 4 millimeters in thickness, and that it is often of such paper like delicacy that a tap with the finger nail will break through it and dehiscences due to atrophy of the bone in old age may be present, the peri-orbita then lying in contact with the dura. Similar dehiscences may occur in the floor of the orbit whereby the contents are only separated from the lining of the maxillary sinus by the peri-orbita. The variations in the sinuses, which are of especial importance in the relations of the lacrymal sac, are well discussed.

The question of the involuntary orbital muscles of the orbit and their possible importance in the mechanism of exophthalmos is fully treated. This point, surprisingly enough, has never been settled for ophthalmologists. In the region of the inferior orbital fissure is a mass of smooth muscle fibers fused with the peri-orbita. This is the "orbital muscle of Mueller" innervated by the sympathetic, which has been thought to protrude the eye by becoming thicker during contraction. The author points out that while in animals it may be of importance, in man it is purely vestigial and excitation of its sympathetic innervation does not cause protrusion of the globe. It is too small, he concludes, to cause pro-

trusion of the globe by pressure on the orbital contents and the veins which pass through it are too small to produce the same effect by their occlusion. The other muscle which has been considered of importance in exophthalmos and which is often referred to as the protrusor bulbi, is the peri-bulbar muscle or *musculus capsulo-palpebralis* of Landström. Landström's muscle, it may be noted, is erroneously figured in Bing's *Gehirn und Auge* as being at the apex of the orbit, evidently by confusion with the orbital muscle previously described. (Reviewer's note) Landström's muscle itself extends as a membrane around the anterior half of the globe, being continuous anteriorly with the involuntary muscles of the lid. Since it lies mainly in front of the globe the author evidently does not believe that its contraction could cause exophthalmos, although it could, as Adler apparently proved, raise the intra-ocular tension by compressing the globe. He believes the most probable cause of the exophthalmos in Graves' disease is dilatation of the orbital blood vessels by excitation of the sympathetic nervous system. He has dissected two orbits of patients dying of Graves' disease without finding anything abnormal.

In the section on the cerebral pathways, modern work, especially that of Brommer on the visual pathway and the retinal representation in the occipital cortex, receives careful discussion.

The format of the book and its illustrations are up to the best standards and the work forms a fitting companion to J. Parsons Schaeffer's work on the nose and paranasal sinuses in the library of anyone practicing surgery of the head as well as of the ophthalmologist.

SAMUEL R. GIFFORD.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

OXFORD MEDICAL PUBLICATIONS. The Early Diagnosis of the Acute Abdomen. By Zachary Cope, B.A., M.D., M.S. (Lond.) F.R.C.S. (Lond.) 6th ed. New York and London Oxford University Press, 1932.

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POSTOPERATIVE PULMONARY SUBVENTILATION¹

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Abdominal section is a bit below the belt and the patient is always winded by it.—W. Pasteur 1910

THE significance of atelectasis as an important postoperative complication is now well recognized. The numerous factors which play a part in the production of atelectasis have been discussed previously (4). It is our purpose here to indicate some of the causes of pulmonary subventilation and to point out the relationship between this condition and postoperative atelectasis.

The etiology of atelectasis has attracted the attention of many workers. It is now fairly well accepted that atelectasis results from bronchial obstruction as shown by the work of Coryllos and Birnbaum, Brunn and Brill and others.

It is generally recognized that it is an upper abdominal operation that predisposes to atelectasis. Sise (21) for example found that postoperative lung complications occurred after 0.5 per cent of operations on the extremities, 1 per cent after operations on the lower abdomen and 10 per cent after operations on the upper abdomen. A. L. Brown (3) and others have found a similar distribution. Studies on the vital capacity have given parallel findings (8). Head for example found an average reduction in vital capacity of 8 per cent after hemorrhoidectomy while it was reduced from 78 to 88 per cent after

operations on the stomach. It was first thought that such a fall in vital capacity after abdominal operation was due in part to the pain of vigorous respiration following surgery. But Sise (22) has pointed out that the deep respiration induced by carbon dioxide inhalation does not cause excessive pain in the postoperative patient.

William Pasteur (16) in 1908 showed that there was a limitation of motion of the diaphragm after upper abdominal operations. Recently Muller, Overholt and Pendergrass (14) studied this question more thoroughly in 25 selected cases of upper abdominal operations on the stomach and gall bladder. They found diminished expansion at the bases of the lungs in all cases; in 80 per cent there were suppressed breath sounds in 20 per cent bronchial breathing and in 56 per cent rales. Yet only three of their patients had cough and dyspnea. They concluded that these changes can be considered as a normal accompaniment of every upper abdominal operation and named the syndrome pulmonary hypoventilation.²

We have been interested in the relationship between upper abdominal operations and these described changes in pulmonary physiology. Our method was to study in the same animal the effect on pulmonary compression of various surgical procedures such as anesthesia, abdominal incision, traction on ab-

¹Read before the sixteenth annual Clinical Congress of the American College of Physicians, April 7, 1932, San Francisco. From the Department of Surgery, Division of Thoracic Surgery and the Pharmacological Laboratory, University of California Medical School, and supported in part by the J. J. and Nettie Mack Foundation.

²A more consistent term would be pulmonary subventilation, and since the latter would also avoid the possibility of confusing "hypo" with "hyper" it was decided to employ it in this paper.

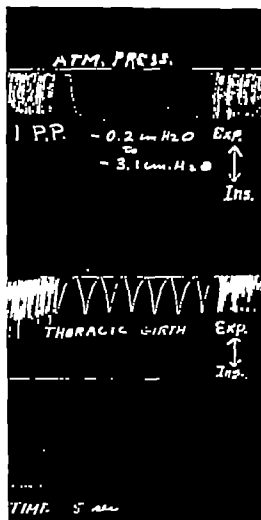


Fig. 1. Kymographic tracing of intrapleural pressure and respiratory movement in a normal unanesthetized dog. The downstroke in both tracings is made on inspiration and the upstroke on expiration. I.P.P. indicates intrapleural pressure. Figures are in centimeters of water.

dominal viscera, and pressure on the abdomen. The state of pulmonary compression or distention was determined by means of intrapleural pressure. Trochars were placed in the intrapleural cavities of the dogs, and by means of branched tubing both manometric and kymographic records were obtained. We also made blood pressure observations.

Figure 1 shows what may be considered a normal curve. As is well known intrapleural pressure is normally subatmospheric due to the stretch of the elastic lung tissue. During

inspiration as the thorax is enlarged, there is greater stretch and the pressure becomes more subatmospheric. During expiration it becomes more positive since the stretch is reduced but normally it is still subatmospheric. Thus, the greater the lung is compressed the more positive does the intrapleural pressure become. The more the lung is distended by a deep inspiration, the more subatmospheric or negative does it become. A pneumograph was placed on the dog's chest in order to determine the relative expiratory or inspiratory position of the thorax.

The first surgical procedure we studied was ether anesthesia (1). The effect is quite complicated (Fig. 2). At first there is violent respiratory movement which corresponds to the second stage of anesthesia. As the animal goes into the third stage of anesthesia, one notes a gradual and very definite rise in intrapleural pressure accompanied by a gradually decreasing thoracic girth. A rise in intrapleural pressure means less lung distention or relative lung compression. This may be due to paralysis of the intercostal muscles in the face of a constant lung elasticity for in deep third stage anesthesia the intercostal muscles can be seen to be sucked in during inspiration.

Abdominal incision further increases intrapleural pressure (Fig. 3). This might be explained by Overholt's theory that pulmonary subventilation is due to pneumoperitoneum which he thinks occurs after abdominal incision (15). The intraperitoneal pressure is normally subatmospheric and he has found it increases somewhat after abdominal incisions. Pneumoperitoneum occurs after many surgical procedures as can be seen in Figure 4.

Assistants often get tired during a surgical operation and may rest on the abdomen. This further increases intrapleural pressure or causes further lung compression as may be illustrated by reference to Figure 5. Clear evidence is here afforded of the possibly harmful effects of thoughtless leaning on a patient's abdomen during an operation.

Traction on any abdominal viscus like the stomach or mesentery further increases the pressure and causes more pulmonary compression (Fig. 6). It is suggested that

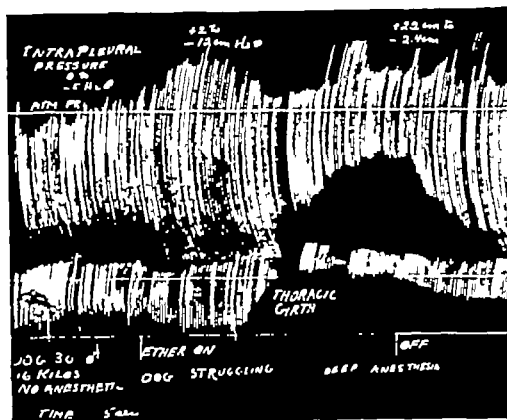


Fig. 2 Kymographic record of intrapleural pressure and thoracic girth in a dog showing effects of ether. The intrapleural pressure is increased and the thoracic girth decreased in deep anaesthesia.

during operations in which an organ is put on a continuous stretch there must be a marked effect on respiration.

To the question are these changes purely reflex and do they disappear after the abdomen is closed and anaesthesia stopped the answer is apparently no as may be deduced from data offered in Table I. Before surgery the intrapleural pressure was -3 centimeters water to -8 centimeters water. After the anaesthesia was stopped and the abdomen closed the pressure was $+3$ to -6 . The total increase in intrapleural pressure at the end of expiration in this case was 6 centimeters of water. The cause of the increased intrapleural pressure is probably the rise in the diaphragm which Pasteur (16) first described in 1908. A roentgenogram of a normal pre-operative chest is shown in Figure 7. After surgery it can be seen that the diaphragm has risen somewhat causing the heart to assume a more horizontal position but the mediastinum has not shifted (Fig. 8). It is the base of the lung that suffers most, and as a result bronchial breathing and râles might be heard in a case like

this. It should be emphasized that bronchial breathing diminished expansion and râles heard at the bases of the lung following abdominal surgery do not necessarily mean pneumonia.

Pulmonary subventilation also occurs in other conditions. Pasteur (17) in 1890 studied

TABLE I.—INTRAPLEURAL PRESSURE CHANGES IN DOG DURING GASTRO-ENTEROSTOMY

Time		Intrapleural pressure expiration cm. H ₂ O	I. trapeural pressure inspiration cm. H ₂ O
1:59	Before ether	-3	-8
2:00	Anaesthesia started dog struggling	$+3$	-20
2:05	Deep anaesthesia	$+2$	-7
2:20	Peritoneum opened	$+2.5$	-7
2:30	Gastro-enterostomy	$+3$	-6
2:40	Gastro-enterostomy	$+3$	-6
3:00	Peritoneum closed	$+3$	-6

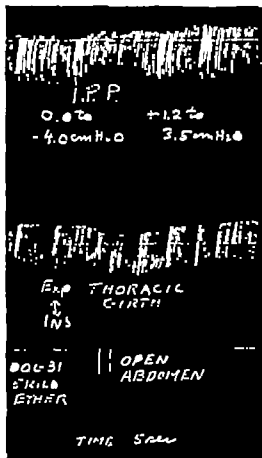


Fig. 3. Kymographic record of intrapleural pressure and thoracic girth in a dog under ether anesthesia showing effect of opening the abdomen.

15 cases of diphtheritic paralysis of the diaphragm. He found percussion dullness and bronchial breathing in many of the cases but at autopsy he found atelectasis. Elderly patients who have been bedridden for some time due to such conditions as typhoid fever or fractured neck of the femur suffer from pulmonary subventilation. It also occurs in tympanites as is seen in this case (Fig 9). After the tympanites has been removed by suitable treatment the diaphragm again assumes its normal level (Fig 10).

The increased intrapleural pressure induced by surgery might be expected to have a profound effect on circulation. Physiologists have long recognized the importance of the negative pressure in the thorax in aiding venous return. An increased intrapleural pres-

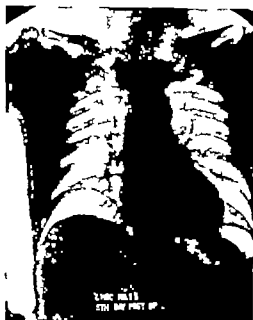


Fig. 4. Pulmonary subventilation produced by a pneumoperitoneum after abdominal operation.

sure would therefore impair venous return. Lister has suggested that venous stasis is an important factor in the formation of post operative emboli. Kountz, Alexander and Dowell (10) found that the increase in intrapleural pressure in emphysema causes an increased venous pressure. The increase in intrapleural pressure causes a lowering of arterial blood pressure (Fig 11). Pulmonary subventilation might therefore be a factor in the lowering of arterial blood pressure found after surgery.

The pulmonary compression induced by surgery helps explain the decrease in vital capacity found after abdominal operations. Pulmonary compression is also an adequate explanation for diminished expansion, rales, and bronchial breathing or diminished breath sounds heard at the base of the lungs which Muller, Overholt, and Pendergrass found after an upper abdominal surgery (14).

Carbon dioxide inhalations have been found to be a great aid in both the prevention and treatment of postoperative complications (4). Carbon dioxide causes a decrease in intrapleural pressure (20) to its normal subatmospheric level thus counteracting the effects of surgical procedures (Fig 12). If atelectasis

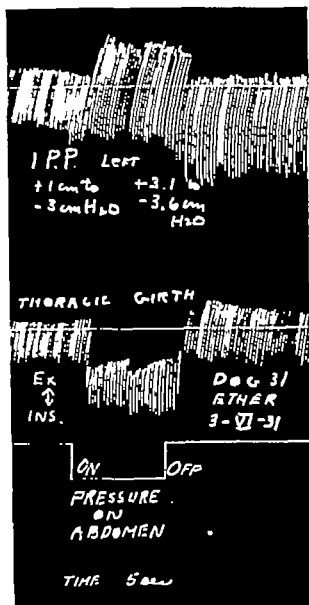


Fig 5. Kymographic record of intrapleural pressure and thoracic girth in a dog under ether anesthesia showing effects of pressure on the abdomen. I.P.P. figures indicate intrapleural pressure in centimeters of water

has already occurred the decreased intrapleural pressure induced by carbon dioxide might be expected to help distend the collapsed lung. Of course there are other reasons why carbon dioxide is an efficacious treatment. It dilates the bronchi (2) raises blood pressure (11), and increases ventilation. The effect on intrapleural pressure seems almost specific in counteracting the harmful effects of surgery on pulmonary physiology.

What is the relationship between the conditions of pulmonary subventilation and obstructive atelectasis? It is suggested that pul-

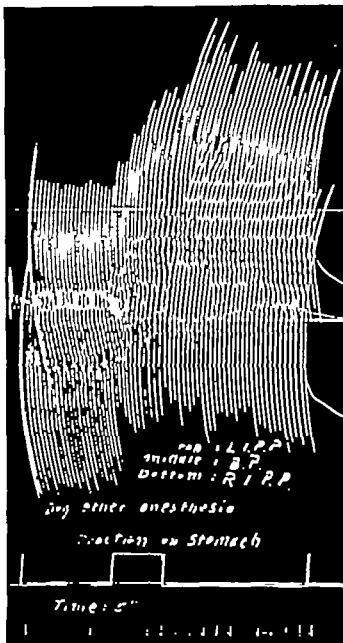


Fig 6. Kymographic record of intrapleural pressure in both chests and blood pressure showing effects of traction on the stomach

monary subventilation is an etiological factor in the production of real atelectasis. Lung compression and decreased ventilation will favor the accumulation of secretion and thus prevent proper lung drainage, thereby leading to the production of mucous plugs. The importance of diagnosing this condition and of administering the proper treatment is therefore evident.

The distinction between pulmonary subventilation and postoperative atelectasis is demonstrated in Table II.



Fig. 7. Roentgenogram demonstrating the normal chest of a patient before operation.

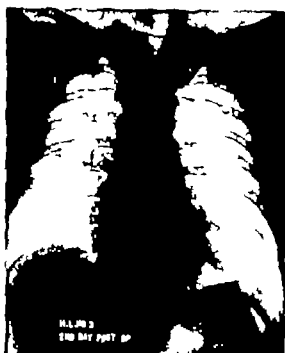


Fig. 8. Same patient as in Figure 7 after abdominal operation. Note increase in the height of the diaphragm and increased thoracic girth.

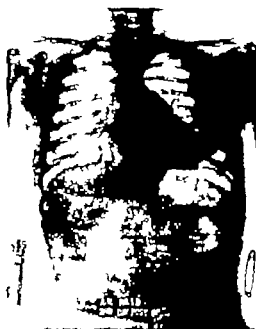


Fig. 9. Tympanites present after operation and producing pulmonary subventilation. Note the position of the diaphragm.

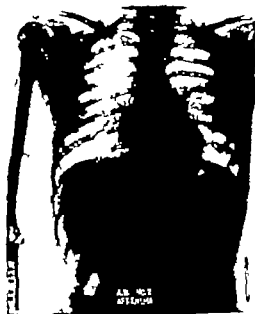


Fig. 10. Same patient as in Figure 9 showing return of diaphragm to a more normal position after the tympanites were relieved by enemas.

TABLE II—DISTINCTION BETWEEN PULMONARY SUBVENTILATION AND POSTOPERATIVE ATELECTASIS

	Pulmonary subventilation	Atelectasis
Incidence	Occurs after 100 per cent of abdominal operation	Occurs after about 2 per cent of abdominal operation
Intrapleural pressure	Increased	Greatly decreased
Distribution	Bilateral	Usually unilateral
Findings	High tracheogram and lung compression	Minor findings
Thorax	Enlarged	Shrunk in unilaterality
Mechanisms	Not changed	Altered: the role of the lungs
Treatment	Carbon dioxide prevents the occurrence of obstructive atelectasis	Carbon dioxide distends collapsed lung. Bronchography if medical treatment is not successful

SUMMARY

Surgical procedures on the abdomen produce pulmonary subventilation by increasing intrapleural pressure. Anaesthesia, abdominal incision, traction on abdominal viscera and pressure on the abdomen tend to increase intrapleural pressure which in turn may raise systemic venous and lower arterial pressure.

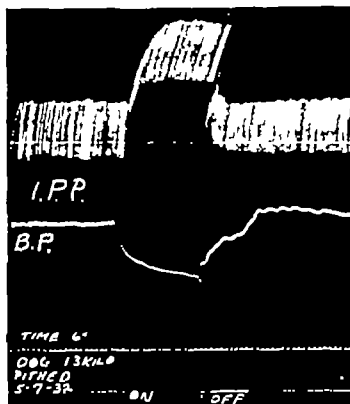


Fig. 11. Kymographic record of a pithe dog under artificial respiration showing the effect of increased intrapleural pressure on blood pressure. Intrapleural pressure was increased by an adjustment of the artificial respiration.

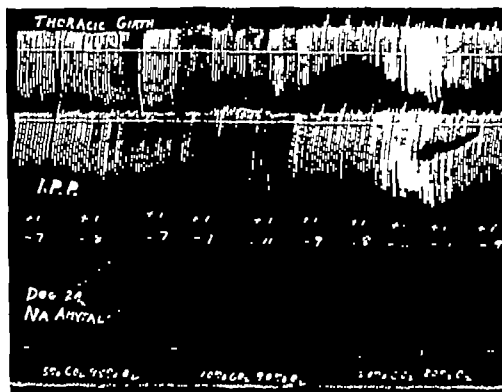


Fig. 12. Kymographic record of intrapleural pressure and thoracic girth in a dog under sodium amytal anesthesia following the administration of different concentrations of carbon dioxide. Intrapleural pressure figures are indicated in centimeters of water.

The increased intrapleural pressure offers an explanation for the decrease in vital capacity and the signs at the bases of the lung found after surgery. Carbon dioxide has been shown to lower intrapleural pressure and therefore to counteract the harmful effects of surgery on respiratory physiology. The relationship between pulmonary subventilation and obstructive atelectasis is pointed out.

We desire to thank Dr Harold Bruus for aid and advice.

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THE RÔLE OF THE PLACENTA IN THE MAINTENANCE OF HYPOPHYSEAL ACTIVITY DURING PREGNANCY¹

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IT HAS been known for many years that the corpus luteum is an important physiological link in the mechanism of pregnancy. This fundamental fact in the physiology of the female reproductive mechanism has been established by a series of beautiful studies which were inaugurated by the epoch making discovery of Fraenkel who at the suggestion of Professor Born investigated the effect of removing the corpus luteum on the maintenance of pregnancy. Fraenkel found that when the corpus luteum was removed from pregnant animals abortion took place. He concluded that this structure produced a secretion or hormone which acted directly upon the uterus to maintain the viable connection between the placenta and the maternal tissues. It is needless to review in detail the important contributions of Loeb (22, 23), Boun and Ancel, Dubreuil and Regaud and others. All of these investigators have advanced additional evidence which has confirmed the essential fact that the secretion of the corpus luteum is of fundamental importance in the maintenance of pregnancy. The recent investigations of Corner and Allen (1, 8) have added the final proof to this conception of the function of the corpus luteum. These investigators prepared an extract from corpora lutea which when injected into rabbits spayed shortly after mating allowed pregnancy to continue throughout its normal period. Furthermore with these extracts they produced typical progestational changes in animals previously sensitized by the injection of estrin. It seems fundamentally sound therefore, to accept as sufficiently demonstrated that the primary function of the corpus luteum is the production of a secretion which is essential in the establishment and maintenance of early pregnancy.

It has been found by repeated experiments both artificial and performed by nature that if nidation fails to occur the corpus luteum degenerates and disappears. Whereas if nida-

tion does occur, the corpus luteum is stimulated and continues to function. The mechanism of this activation of the corpus luteum has eluded final demonstration until recent years. It has been through a series of studies which have been developed largely from an entirely adventitious viewpoint i.e. the study of the anterior lobe of the hypophysis that definite progress has been made.

It seems logical to reason that the factor which is known to be most potent in its action on the ovary might be expected to be the link concerned with the activation of the corpus luteum. In the inception of the work which we wish to present in this communication, this process of reasoning lead us to consider that such a mechanism would in all probability be found to operate through the anterior lobe of the pituitary body since numerous brilliant investigations had demonstrated the profound and fundamental nature of the control exercised by this structure upon the female reproductive organs.

The capacity of the anterior lobe of the hypophysis to produce an effect upon the ovary was demonstrated independently in 1927 by Smith and Engle and by Zondek and Aschheim. These observers found that subcutaneous implantation of anterior lobe tissue into infantile mice brought about a rapid development of the genital tract, with the premature appearance of estrus, enlargement of the ovaries and specific changes in the uterine epithelium. The ovaries were most remarkable the follicles had undergone rapid development ovulation had taken place in many cases and corpora lutea had been formed. In addition, there were numerous blood filled follicles and, in some instances, luteinization had occurred in unruptured and even in immature follicles. In addition to being of fundamental physiological importance this reaction has been utilized as a practical basis for much of the subsequent work on the anterior lobe of the hypophysis and has con-

¹This work has been aided by grant from the National Research Council Committee for Research on Problems of Sex. Part of the animals used in these experiments were drawn from the rat colony which has been supported by a grant from the Commonwealth Fund.



Fig. 1. Drawing of the ovaries, uterus, and tubes of normal mouse N 5-840 after fixation in Bouin. This mouse had an index of 1 and was the largest normal in our series. $\times 6$.

stituted an exceedingly delicate biological test for the presence of the hormone or hormones of this gland. It is not within the province of this paper to discuss the so called duality of the anterior lobe secretion or the possibility as suggested by Philipp and others that the hormone present in the urine of pregnant women is in reality a placental hormone. Studies have been carried out by Friedman Wolfe and others on the relationship between the hypophysis and ovulation. In all these investigations it has been repeatedly demonstrated that the anterior lobe possesses a very powerful capacity to stimulate the production of lutein tissue in the ovary under a variety of conditions. All of the studies which have been directed toward the solution of this particular problem have strongly supported the concept of a relationship existing between the anterior lobe and the corpus luteum.

The considerations just outlined lead to the assumption that there is probably some peculiarity in the state of pregnancy which increases the capacity of the anterior lobe of the hypophysis to stimulate the ovary and more especially the corpus luteum. It was on

this assumption that the experiments reported here were inaugurated and since it is obvious that the placenta is the most characteristic and pertinent structure developed during pregnancy it seemed probable that it would have some specific action on the anterior lobe. The same line of reasoning included the possibility of the controlling factor being decidual tissue or the fetus itself. The former was thought to be unimportant since the experiments of Loeb had demonstrated that the presence of experimentally produced placentaloma was insufficient to maintain the corpus luteum in a state comparable to the corpus luteum of pregnancy. The rôle of the fetus is easily excluded as a source of the unknown secretion by the consideration of hydatidiform mole and chorio-epithelioma. In these interesting conditions the endocrine activities of pregnancy are maintained after the fetus has been expelled from the body.

The capability of the placenta to produce a hormone was first suggested by Halban who from clinical observations, reasoned that the placenta was a gland of internal secretion. In the following year Lane-Clayton and Starling made a weak aqueous extract from placenta and fetus and found that this extract had a definite effect on the mammary gland. Later extracts potent in the estrus producing hormone were made by Hermann Iscoveasco, Frank Allen and Doisy and many others.

The estrus producing substance furnished by the placenta has been studied extensively and it has been shown that this substance is similar to the hormone of the ovarian follicle in the biological reactions which it produces. In 1920 Hirose demonstrated that the intraperitoneal injections of placenta produced marked changes in the ovaries of rabbits. The increase in number and size of the corpora lutea was especially noteworthy. These changes were obtained with fresh placenta, but were not obtained with the ether or acetone extracts. He also found that this effect was obtained only from placenta of the first half of pregnancy. Hirose's paper has not been available to us in the original. The information here given was obtained from the paper by Murata and Adachi who have confirmed and extended Hirose's experiments.

They found that if the animals had been previously spayed they could not produce an enlargement of the uterus by placental extracts, and concluded that the estrin content of placental material was not responsible for the change but rather that the placental material had in some way influenced the ovary to increase its own production of estrin. Zondek and Aschheim in addition to their discovery of the ovary stimulating hormone in the blood and urine of pregnant women found that implants of small amounts of placental tissue produced a somewhat similar action. Wiesner prepared an extract from human placenta by extracting it with sulphosalicylic acid which contained a considerable amount of the ovary stimulating hormone and also some growth hormone.

In considering the evidence presented it was felt that the mechanism for the maintenance of hypophyseal activity must reside in the placenta, the secretion of the placenta stimulating the hypophysis and that of the hypophysis in turn stimulating the ovary. With this thought in mind Burch and Cunningham carried out a series of experiments which were reported in a previous paper in 1930. These experiments were conducted as follows. A commercial alcoholic extract of placenta was obtained and this material was injected into a series of spayed rats. These rats were later killed and the hypophyses removed and transplanted into the subcutaneous tissues of infantile mice. The mice were given two transplants, each consisting of the entire anterior lobe from a rat which had been treated as already outlined. These mice were sacrificed on the fourth day and the genital tracts studied. A series of control experiments were also carried out. These consisted of mice into which hypophyses of spayed rats which had not been injected with the extract were transplanted. In these experiments it was found that the size of the ovaries in the animals of the experimental group were approximately three times larger than those of the control animals. These experiments are being reported in detail in this paper (see Tables I, II and III). The extract which was used was obtained in several shipments. The estrin content was carefully

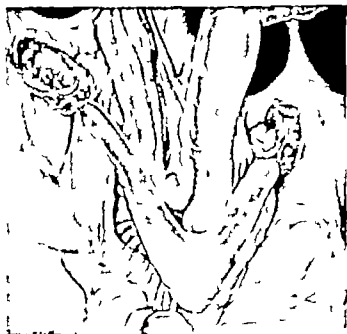


Fig. 2. Drawing of ovaries, uterus and tubes of control mouse No. 41 702 after fixation in Bouin. This animal had an index of 2.6 which is approximately the average of this group. $\times 27$.

standardized as at that time estrin was considered to be the most important of the various substances known to be present in the placenta. This extract was prepared by alcoholic extraction of fresh human placenta and as it was in the experimental stage there was some variation in the method of preparation which however did not differ in the fundamental use of alcohol as a preliminary solvent. The variation in the method used in preparing the extracts may account for the marked variation which we obtained in the individual animals in this series of experiments. Kraus has approached the problem from much the same viewpoint as our own. He employed the histology of the ovary as a measure of the activity of the anterior lobe. He concludes that the follicular growth of animals receiving hypophyses from donor animals previously treated with folliculin or placenta extract is variable but sometimes increased.

Following our report, it was shown by Leonard, Meyer, and Hisaw that the ovary stimulating capacity of the anterior hypophysis was diminished by repeated injections of estrin over a long period of time. Kunde, d'Amour, Gustavson, and Carlson obtained



Fig. 3. Drawing of ovaries, uterus, and tubes of experimental mouse No. 46-835. This animal had an index of 0.7 and was one of the three largest of this group. Note the large bursa on each ovary. $\times 6$

the estrin hormone from the urine of pregnant women and injected this daily into immature dogs over a period of 6 to 17 weeks. They found that the anterior lobes of these dogs were much smaller than those of normal dogs and that the ovaries were also smaller than normal. These experiments indicate very clearly that estrin could not have been the material that produced the changes which we observed in our previous experiments. It is to be noted here that we could not determine the nature of the mechanism involved and as stated in our paper "the stimulating effect produced on the anterior lobe was increased by an extract of placenta which contained a high concentration of estrin. The experiments referred to have clearly demonstrated that estrin could not have been the responsible agent in our previous extracts."

In 1930 there appeared a series of studies by Collip (5, 6, 7) on the placenta, which offered a wholly new line of approach and interpretation for the work which we have referred to. Collip has extended the studies of Wiesner and has, by means of alcohol, acetone and ether extractions, obtained three



Fig. 4. Photograph of normal animal No. 5-840 and experimental animal No. 46-835, after fixation in Bouin. \times

fractions which are relatively specific in character. The original extraction was made with acetone. After concentration and removal of the acetone *in vacuo* he subdivided his fractions according to their solubilities in alcohol, ether and water. One fraction which he obtained contained estrin. The second he has called the "anterior pituitary-like substance" and has found that its action is biologically similar to the ovary stimulating hormone which is found in the urine of the pregnant and in the substance of the anterior lobe of the hypophysis. His third fraction he has called "emmenin." This substance has an estrogenic action which is not interfered with by the removal of the hypophysis. Evans, Meyer and Simpson have shown that the urine of pregnant women contains a substance which activates the hypophysis in regard to its ovary stimulating capacity. This substance they have designated as "prolan," after Zondek and Aschheim. It is possible that this is the substance which was the active principle in our original extracts. It seems from the experiments which we are reporting in the second part of this paper that our original hypothesis of placental stimulation of the hypophysis is correct and that the active agent is either emmenin or the substance resembling that from the anterior pituitary gland or a combination of one or both of these with estrin.

FIRST SERIES OF EXPERIMENTS

All of the tables are arranged in the same fashion and therefore a general statement

TABLE I - NORMALS

Number	Wt. mouse	Ovary measurement	Index	Average wt.	Days post op.
31-630	10	0.8 1.4 2.1	—	—	—
75-033	9	0.8 2.1 2.0	5	—	—
77-035	9	0.8 2.75 0.8	1	—	—
73-026	9	0.8 1.0 0.8	—	—	—
Average			6	—	—

TABLE II - FIRST SERIES CONTROLS

Number	Wt. mouse	Ovary measurement	Index	Average wt.	Days post op.
12-650	10	1.0 1.0 0.6	6	5	—
3-660	1	1.3 1.1	—	5	—
12-704	12	0.5 1.8 1.0	7	—	9
1-705	12	1.2 0.8 1.1	—	10	—
10-709	12	1.4 1.1	1	10	—
40-781	1	1.1 1.3	1.6	5	—
41-797	10	1.2 0.8 1.1	6	10	—
43-791	1	1.1 1.0 0.9	0	10	—
41-791	1	1.0 1.2 1.2	4	5	—
44-795	10	1.3 1.0	1.5	10	—
43-799	10	1.1 0.8 1.0	1	10	—
60-819	12	0.8 1.4 0.7	1.6	—	—
67-820	10	1.2 1.1	8	10	—
65-811	10	0.8 1.0	4	10	—
69-813	9	1.0 1.4	4	—	—
Average			9	15	—

regarding the data included in them seems advisable. The ovaries were fixed in a uniform manner dehydrated and embedded as carefully as possible and serially sectioned at seven microns. The largest section was measured by a micrometer eyepiece which had been standardized against a micrometer slide and the number of sections obtained from each ovary counted and multiplied by seven in this manner three dimensions of the ovary were obtained which when multiplied together, gave the index. This index is not an accurate measure of size but we feel that it is more accurate for purposes of comparison than any other method which we have tried. It is our belief that an index obtained in the fashion outlined gives a very delicate measure for comparison of these small masses of tissue.

In the tables which include animals that have received transplants of hypophyses from donor rats we have included certain additional data. It was assumed that the average weight of the rats would indicate, at least to some extent, the amount of hypophyseal tissue transplanted. It did not seem wise to weigh the individual hypophyses because of the added exposure to possible infections. It is not legitimate to assume that the volume or mass of the hypophysis will bear an accurate ratio to the total weight of the animal but it seemed probable that there would be a sufficiently definite relationship for these



Fig. 5 Photograph of experimental animal No. 40-835 after fixation in Bouin. Note difference in size of ovaries. This was due to extreme distention of bursa on one side. X2

weights to be of some significance. We have also included the number of days transpiring between the spaying of the donor rats and the utilization of their hypophyses for transplants. As will be seen in the discussion of the experiments this interval seems to be of considerable importance. In the animals of the earlier experimental series which received injections of commercial extract of placenta the units of estrin present in the placental extract were determined and are listed as total number of rat units received by the donor rat during the course of the experiment.

In Table I (see Figs. 1 and 6) we have presented a series of normal immature mice as a basic measurement for the effects produced in the various experimental groups of animals. In examining Table I it is obvious that the average size of ovaries of normal immature mice as indicated by the index is less than 1. It is unnecessary at this point to describe in detail the histological characteristics of these ovaries as the small immature follicles moderate amount of stroma small bursa and uniform lack of vascular injection are perfectly well known. In Table II (see Figs. 2 and 7) the control experiments for the first series are given. There were fifteen of these animals in which the indices varied from 8 (which is the only animal in the entire group with an index below 1) to 7.2 with an average of 2.9. The size of the ovaries of the control animals have in no single experiment ever been less than the average for the series of normal animals. In other words in all of the animals reported in the control as well as in the experimental group there is definite evidence of hypophyseal effect. Of the control animals only three had an index above four. These animals received hypophyses



Fig. 6



Fig. 7



Fig. 8

Figs. 6 to 14. Photomicrographs of sections of ovaries. The largest section was selected in each case in order to give some comparison in size. This comparison, however, cannot be considered as exact, because in some instances the largest dimension of the ovary was perpendicular to the axis of sectioning. For an exact comparison of size the index must be used. All are magnified 24 times.

Fig. 6. Photomicrograph of section of ovary from normal mouse No. 70-93.

Fig. 7. Photomicrograph of section of ovary from control mouse No. 39-790.

Fig. 8. Photomicrograph of section of ovary of experimental mouse No. 19-701.

from rats whose weights averaged 138 grams. There was in the group of donor rats no variation of very marked character and nothing which could account for the fact that three of the controls were markedly out of line in regard to the index. As a matter of fact the donor rats for mouse 22 averaged 131 grams in weight, which was very close to the average weight of the entire group. Twenty-one days was the average length of time which elapsed between the date of spaying and the

transplantation of the hypophyses. The maximum variation was 3 days, which cannot be considered of great importance.

There were 25 experimental animals in the first series (see Figs. 3, 4, 5, 8, and 9) these are included in Table III. We have divided these animals into sub-tables (A, B, C, D, E) in terms of the batch of material used for injecting the donor rats. This has been done because careful study of the data indicates that a greater similarity exists between members of these different groups than between the members of dissimilar groups. In other words, it is probable that the amount of the particular stimulating substance concerned in the effects described varied considerably from batch to batch, the estrin content, however, remained remarkably constant.

In considering the experimental animals of this earlier group certain factors become very

TABLE IIIA—FIRST SERIES. PLACENTAL EXTRACT BATCH I

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days post spayed
9-708	33		1.6	70	9	
30-704	33		7	16	0	
703	34		4	30	0	
			Average	9	9	

TABLE IIIB—FIRST SERIES. PLACENTAL EXTRACT BATCH II

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days post spayed
14-777	34		3	180	3	
30-776	35		0	3	3	
30-775	35		1.2	43	3	
31-780	35		3	7	3	
31-781	35		2.4	3	108	3
31-782	35		1.3	3	103	3
31-783	35		6.7	54	129	7
31-784	35		3	7	30	7
36-787	70		3	4	148	30
37-788	70		7	9	134	30
			Average	4.7	121	16

TABLE IIIC—FIRST SERIES. PLACENTAL EXTRACT BATCH III

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days post spayed
46-815	124	3	6.3	3.3	167	37
47-820	124	3	4	1.4	43	18
48-837	124	3	7	2.8	67	17
49-838	124	3 1/4	7	3.8	54	18
50-839	124	3	6.3	3	71	18
			Average	9.7	121	17



Fig 9

Fig 9. Photomicrograph of section of ovary of experimental mouse No. 49-838. Note the large corpus luteum.



Fig 10

Fig 10. Section of ovary control mouse 15 second series



Fig 11

Fig 11. Photomicrograph of section of ovary of experimental mouse No. 2 second series (ether extract was used in this experiment)

clear. In the first place there was a wide variation in the size of the ovaries obtained. The smallest ovary in this series had an index of 2.5 and the largest ovary an index of 19. Such a variation as this would be remarkable in experiments of a more standardized character but the number of factors involved in this experiment was so great that any specific control was almost impossible. Of the factors which we are capable of recognizing some of them have been controlled by the nature of the experiment. It is known for example that castration augments the capacity of the hypophysis to affect the ovary. We are not aware of any investigations which have accurately determined differences in the effect produced following variations in the period between castration and the implantation of the hypophyseal tissue into other animals, however the difference in this group of experiments could not possibly have been due to variations in the time. The largest ovaries were not invariably from mice whose rat donors had been spayed over the longest period of time although there is a slight

tendency toward an increase in size incident to greater length of intervals. Experiments 19, 20, 21, 36 and 37 had 19 day intervals, in these experiments the average index was 9.1. Experiments 28, 29, 30, 31, and 32 all had 15 day intervals in these animals the average index was 3.9. On the other hand the intervals in the remainder of the experiments were 16, 17 or 18 days and the indices in these experiments varied over a wide range (2.5 to 16.7). It would seem legitimate, therefore to conclude that the time between castration and implantation was a factor but that the difference of 2 or 3 days (the maximum difference in these experiments) was insufficient to explain all of the changes noted

TABLE III E — FIRST SERIES
PLACENTAL EXTRACT BATCH V

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev spayed
61-9-4	138	8 1/2	1.4 x 1.3 x 1.2	4.8	7	9
			1.4 x 1.0 x 1.0			
62-9-11	138	8	.5 x 1.5 x 1.5	3.4	13.6	10
63-9-6	138	8 1/2	1.0 x 1.2 x 1.7	7.1	12.9	10
64-9-18	138	9 1/4	1.1 x 1.2 x 1.8	4.8	14.0	10
69-9-18	138	9 1/2	1.3 x 1.2 x 1.3	4	12.1	10
				Average	4.8	11.3
					13.3	10

TABLE III D — FIRST SERIES
PLACENTAL EXTRACT BATCH IV

Number	Units	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev spayed
54-8-70	38	8	1.5 x 1.1 x 1.7	8.6	14.4	7
55-8-80	38	8	0.9 x 1.3	6.0	14	17
57-8-8	138	8	5 x 9 x 7	1.8	14.4	17
				Average	8.2	14.7
					14.7	17

TABLE III F — FIRST SERIES AVERAGES

	Index	Average wt. rat	Days prev spayed
Averages from Table III A	11.9	11	10
Averages from Table III B	4.7	12	10
Averages from Table III C	9.7	18	17
Averages from Table III D	8.1	14.7	7
Averages from Table III E	4.8	13.3	10
Average		7.8	13.0
			18



Fig. 12

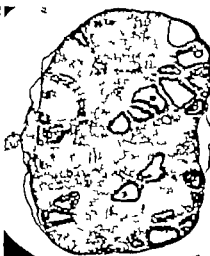


Fig. 13



Fig. 14.

Fig. 12 Photomicrograph of section of ovary of mouse No. 11, second series (alcohol extract)

Fig. 13 Photomicrograph of section of ovary of mouse

No. 18, second series (crude extract was used here)

Fig. 14 Photomicrograph of section of ovary of mouse No. 20, second series (crude extract)

The amounts of hypophyseal tissue which were implanted could of course easily be a factor of importance. The hypophyses were not weighed or measured individually but the relation of the weight of the donor rats to the amount of change observed in the recipient mice was noted. We may assume that those animals showing an index above 10 could be considered as a maximum group. There were 4 of these animals showing an average index of 15; the average weight of the donor rats of these animals was 150 grams. In the next group animals showing indices between 7 and 10 the weight of the donor rats was found to be 104 grams. Grouping together all the animals having indices smaller than 7 the average weight was found to be 130 grams. The larger indices were therefore definitely connected with the heavier animals, but the ratio of increase in the weight of the rats is exceedingly small as compared with the ratio of increase in the size of the ovaries of the mice. Furthermore there are many individual exceptions to this average as, for example experiment 19 which had the largest index but which had next to the lowest rat weight (101 grams) as its factor while experiment 46 with an index of 16.7 which is the next largest index in the group had 194 grams as an average weight of rat donors.

The pelvic viscera (with the exception of the ovaries) from these animals were relatively uniform histologically. The uteri and tubes invariably showed marked effects of hypophyseal stimulation. The uterine epithelium was tall showed many mitoses and some tendency toward pseudostratification. The ovaries were more variable in many there were large masses of lutein tissue and many clearly defined corpora. There were also many large follicles, of which a considerable proportion contained blood. An effort was made to correlate the amount of lutein tissue with the number of enlarged follicles, this was not found to be possible in that the ratio of corpora lutea to follicles varied enormously. In some ovaries there was a predominance of corpora lutea, and in others of follicles in general the impression was gained that in individual masses of lutein tissue predominated slightly over the total number of follicles. It was interesting to note however that in none of the ovaries was there an approximately equal increase in follicles and corpora lutea. Either the corpora lutea or the follicles definitely predominated. The blood vessels were markedly injected in every case and in many instances the bursae were markedly distended with fluid (Figs. 3 and 9). In a few instances blood was seen in these distended bursae. Ova

were found in the tubes in considerable numbers and were also seen embedded in masses of lutein tissue and in blood filled follicles. There was no particular correlation found between the size of the ovary and the relative amounts of lutein tissue and follicles. One of the largest ovaries obtained consisted almost entirely of lutein tissue while another of the larger ovaries consisted largely of graafian follicles. This was found to be equally true of those ovaries having smaller indices. After consideration of the results obtained in this group of experiments it does not seem possible to determine any specific liberation of a particular hormone by the hypophysis.

SECOND SERIES OF EXPERIMENTS

When it became obvious from the studies of Leonard Meyer and Hisaw that estrin could not be the factor involved in our experiments it seemed advisable to repeat them in order to determine whether there could have been some error in our procedure or whether the agent causing the changes observed could be some other placental factor. It was considered as more important to obtain a definite separation of the estrus producing hormone than to attempt to isolate all three of Collip's fractions inasmuch as we had no assurance as to which of these (or perhaps some other substance) might be the specific material involved in producing the results already described. It was our object to control our original experiments in a single series of new experiments and to determine in addition if, by this method we could obtain a depression of the ovary stimulating capacity of the hypophysis by estrin similar to that found by Leonard Meyer and Hisaw. These experiments have accomplished both purposes. We found that animals injected with the fraction containing estrin showed less ovary stimulating material in their hypophyses than did control animals and also that the alcoholic extract contained some substance or substances which markedly increases the capacity of the hypophysis to stimulate the ovary.

These experiments have been carried out by one of us (Klingler) and because of certain difficulties, have differed in minor ways from

the original series in the manner of their execution. The donor rats were much larger and the interval between spaying and transplanting was longer than in our original experiments. It is therefore impossible to compare quantitatively the results obtained with those of the earlier group.

All of the extracts used were prepared from fresh human placenta. The method of preparation consisted of repeated extractions in 95 per cent alcohol of finely pulped placenta under reduced pressure at room temperature and in an acid medium. Following each addition of alcohol the material was filtered. Ten volumes of alcohol were used with each extraction the material was then concentrated and all the alcohol removed. The remaining material constituted our crude extract. In preparing the extract containing estrin enough distilled water was added to the crude extract to permit of extraction of the lipoids by ether. The ether soluble material contained the estrin and the remaining extract contained the alcohol soluble material. Further extraction was repeated eight times following which all of the ether was removed under reduced pressure at room temperature.

Sixty adult female rats were spayed and about 3 weeks following the operation were divided into four groups, one group received crude extract one the ether extract containing estrin one the alcohol soluble fraction and one group was used as a control (spayed but not injected). The injections were made subcutaneously twice daily for 6 days at the end of which time the animals were killed and their hypophyses, in the intact state were implanted subcutaneously into infantile female mice. Each mouse received two hypophyses. These were implanted on successive days. The mice were sacrificed on the fourth day and their genital organs examined. The vaginas were open in each case and the uteri were enlarged reddened and injected.

In considering the averages presented in Tables IV, V, VI and VII, one sees that the indices of the entire group of animals included in the second series are larger than those in the first series. This increase is proportionately larger throughout the group and can be clearly demonstrated by comparing the 29

TABLE II—SECOND SERIES. CONTROLS

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
1	8	2.5 x 2	7.1	251	31
2	8	2.5 x 2	7.7	251	31
14	8	2.5 x 2	7.8	250	31
3	8	2.8 x 2.4	4.6	30	31
		2.8 x 3	—	—	—
		2.8 x 3	—	—	—
		Average	5.9	33	31

TABLE V—SECOND SERIES ETHER EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
1	8	3 x 2.7	4.8	270	3
2	8	3 x 2.7	4	270	3
3	8	5 x 6	3	270	3
4	8	5 x 6	4	275	3
5	8	9 x 4	7	273	3
		Average	3.7	27	3

average shown in Table II with the 5.9 shown in Table IV and the 7.8 average of Table III F to the 15.8 average of Table VII. In examining these differences we are forced to interpret them as probably resulting from two factors: (1) the greater average weight of the rats used as donors and (2) the longer period of time transpiring between the date of castration and the time at which the rats were sacrificed. In examining these experiments somewhat more in detail, it is interesting to note that the indices of the control series were considerably larger than those of the animals which had received the ether extract (estrin). One might be inclined to presume that the difference of 6 days in the interval between spaying and implantation would be in favor of a smaller size of ovary in the ether extract group. But this should be compensated for at least in part by the slightly greater average weight of the rat donors. We should therefore, be able to assume that the control series is adequate in this connection and that the actual difference in ovary index between 5.9 and 3.7 represents the specific inhibitory effect which was produced upon the anterior hypophysis by the injection of estrin (ether extract). These results are in accord with the findings of Leonard Meyer and Hisaw and Kunde, d'Amour, Gustavson and Carlson.

The ovaries of the control animals contained corpora lutea and follicles in about equal proportions. Some of the follicles were quite large, and a few contained blood. The ovaries of the animals which received the ether ex-

TABLE VI—SECOND SERIES ALCOHOLIC EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
6	8	9 x 8	9.6	260	29
7	8	7 x 2.8	3	37	29
8	8	3 x 2.8	3.3	353	29
9	8	3 x 2.8	3.3	33	29
10	8	6 x 7	7.3	243	29
		6 x 3	—	—	—
		Average	6.9	253	29

TABLE VII—SECOND SERIES CRUDE EXTRACT

Number	Wt. mouse	Ovary measurement	Index	Average wt. rat	Days prev. spayed
16	8	4.3 x 2	4.9	240	23
17	8	3.3 x 2.5	14	30	23
18	8	3.8 x 2.5	14	30	23
19	8	2.4 x 2.5	3.3	229	23
20	8	2.5 x 2.8	3.7	247	23
		2.4 x 6	—	—	—
		Average	5.8	247	23

tract contained a few corpora lutea, a few blood filled follicles and a larger number of follicles which did not contain blood. The latter varied considerably in size some being quite large (Fig. 11). In Table VI we have listed the five animals which received the alcoholic extract. These 5 animals showed an average index of 6.9 with extremes of 3.3 and 9.6. These indices are somewhat larger than those of the controls but not so markedly so as was found in the original series of experiments, with which they cannot however be directly compared. On the other hand when compared with the animals tabulated in Table V (ether extract) it is seen that the average index is almost double which obviously indicates a marked divergence in the effects produced by the ether and alcoholic extracts. The histological changes in the ovaries of the animals which had been given the alcoholic extract consisted of an increase in both corpora lutea and follicles, the latter slightly predominating. The follicles were moderate in size and comparatively regular. A few were filled with blood. The corpora lutea were usually distinctly outlined.

When one considers the five animals included in Table VII which received transplants from rats previously infected with the crude extract it is obvious that a more marked

effect was produced. It is possible that this exaggerated effect was in part due to the slightly increased period between the spaying of the rats and the implantation of the hypophyses. It does not seem probable, however, that this factor could account for the tremendous increase which was found. The differences between the animals injected with the alcoholic and crude extracts must have been due to a failure to remove all of the active substance by our chemical extraction or to some synergistic action of the substances present in the crude extract. Further experiments are under way at the present time with improved methods of extraction to determine which of these possible explanations can be definitely substantiated. These experiments are not, however, needed to establish the primary point of the presence in the placenta of some substance which increases the capacity of the anterior hypophysis to stimulate the ovary.

The ovaries of the animals of the crude extract group differed markedly from all the others of the second series. In 4 of the animals there was a marked predominance of lutein tissue, some of which was in discrete masses, while some was more diffuse and suggested luteinization of unruptured follicles. The fifth animal (No. 20) showed a very large number of follicles which were quite even in size and most of which did not contain blood (Fig. 14). In mouse No. 16 one ovary consisted almost entirely of lutein tissue while the other had about the same number of follicles as corpora lutea. In animals Nos. 17 and 19 there was a marked predominance of lutein tissue there being at least three or four times as many corpora as there were follicles. In animal No. 18 the number of corpora lutea was about double that of follicles. In general therefore it is clear that the amount of lutein tissue predominated over the number of follicles, except in the one of the five experiments, in which there was an almost complete absence of corpora.

DEDUCTIONS

The experiments outlined have clearly demonstrated that the ovary stimulating properties of the anterior hypophysis can be increased by a placental extract, which probably

contained all three of Collip's fractions, while estrin, one of the components of the crude extract, definitely depresses the hypophysis. It is obvious that the stimulation may be the effect of the anterior pituitary like substance alone or it may be the effect of emmenin and estrin in combination with each other or in combination with the anterior pituitary like substance. There is of course always a possibility that the effect observed was produced by some entirely new substance although this seems unlikely, and it is not at present considered necessary to explain our results. The possibility that there are in the placenta two substances having a diametrically opposite action on the anterior lobe raises the question of a possible balance of these opposing forces under normal conditions. The proper understanding of this balance is full of interesting possibilities.

One must also consider the question of the reaction shown by these experiments in terms of the normal animal. The removal of the ovaries was carried out in order to eliminate the estral cycle and thereby standardize the animals but it is entirely possible that the presence of these organs intact may furnish some additional mechanism which would modify the effects of these extracts on the hypophysis. One fact which must be remembered is that, in spayed animals, there is a storage of secretion in the hypophysis which does not take place in the normal animal. It is entirely possible that, in our experiments, modification of this mechanism has been produced.

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THE FALLACY OF CHEMICAL STERILIZATION OF SURGICAL CATGUT SUTURES

WITH PARTICULAR REFERENCE TO THE USE OF COPPER SALTS, PEPPERMINT OIL, AND MERCURY

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THERE are two principal methods in use today for subjecting catgut sutures to sterilization one is with heat and the other is with chemicals. The primary object of this research work was to determine whether any of the chemical compounds which are on the market or which are otherwise available will exhibit reliable and effective bactericidal properties when used for sterilizing surgical catgut. Efficient germicidal action is claimed or has been demonstrated for many chemical compounds when used for various surgical medical or laboratory purposes. Hence the initial studies in this investigation were confined to the sterilizing action of such compounds on catgut but as the work progressed many other chemical compounds were included in the study.

Contaminated commercial catgut sutures The chemical method of sterilization has been given, probably a more extensive trial in Germany than elsewhere. And yet Knorr found in his investigations during a 4 year period of bacteriological examination of original packages of catgut obtained from commercial sources or from clinics or from physicians, that at least 80 per cent did not meet the officially established requirements for sterility, both pathogenic and non-pathogenic bacteria being found in the sutures. In England, Bulloch purchased and examined bacteriologically 77 sutures manufactured by 8 different makers. Of these, he found 58 sutures or more than 75 per cent to be infected with living bacteria. In this country, Meleney and Chatfield made a 3 year study of the sterility of catgut sutures obtained from surgical clinics or purchased from the open market throughout the country. They found that 12.5 per cent of 174 sutures examined were contaminated with spore bearing bacteria. Sutures from 10 manufacturers yielded no growth, while the products of 7 firms showed bacterial growth ranging from

5 per cent to 67 per cent of specimens tested.

Chemicals previously used The chemical compounds which have been used in an attempt to destroy the bacteria commonly present in raw catgut are almost legion. In his investigations Macle tried out various strengths of alcohol, glycerol chloroform oil of cloves, oil of eucalyptus phenol lysol formalin, acrislavine, brilliant green crystal violet, biniodide of mercury perchloride of mercury and silver nitrate but found them lacking in true germicidal properties so far as catgut was concerned. In his review of the disinfecting power of numerous chemicals Bulloch found that phenol, perchloride of mercury biniodide of mercury silver compounds oil of juniper oil of turpentine oil of lavender, oil of cajuput oil of eucalyptus, formalin, picric acid, hypochlorites, chlorine water bromine, pyoktanin, methyl blue eosin acrislavine, tannic acid lysol tellurium sulphur dioxide alcohols, ether, chloroform acetone, and benzene were inefficient as sterilizing agents for catgut.

Present researches on chemical sterilization During the past 3½ years I have made an intensive study of the possibility of effectively sterilizing catgut by means of chemical treatment. In this investigation, I tried out a great many chemical substances including mercuriochrome mercuriophen, merthiolate metaphen, potassium mercuric iodide hexylresorcinol tribromoresorcinol orthophenylphenate ethyl hydrocuprene, tribrometanaphthol copper cyanide, copper chloride copper sulphate copper sulphate plus methylene blue zinc sulphate, peppermint oil oil of tea tree (*Melaleuca alternifolia*), hydrogen peroxide, malachite green, pyridium, iodine, iodine plus potassium iodide myodine, parachlorometacresol, diacetoxymercurioorthocresol parachlorophenol, and chlorthymol ester.

Several thousand sutures treated with various strengths and combinations of these

chemicals, were prepared under various conditions as regards duration of the chemical sterilization treatment, the hydrogen ion concentration and temperature of the solutions etc. the chemical sterilization treatments being applied to catgut ribbons to raw catgut strings, as well as to catgut artificially infected with a sporulating culture. For controls duplicate lots of the chemically sterilized sutures were subjected to heat sterilization. The finished sutures were tested bacteriologically by the method of Meleney and Chatfield (10).

In searching the literature relating to the sterilization of catgut, I found that rather broad claims are made for copper sulphate and peppermint oil as sterilizing agents for catgut. I also found that these chemical agents are being used for the sterilization of catgut sutures which are claimed to be sterile and which are being used on an extensive scale. Hence it seemed desirable to conduct sufficient experiments with these particular chemicals to check up the claims made for them and to prove or disprove the reliability practicability and efficiency of these chemicals as sterilizing agents for catgut.

No such claims however were found for mercury compounds. But since wide publicity has been given to claims for the germicidal action of some of the mercury compounds now on the market, and in view of the fact that many experiments have been published showing that these compounds exhibit true germicidal action when used for laboratory surgical or medical purposes, I devoted considerable study to the sterilizing action of these mercury compounds on catgut sutures.

Mechanism of disinfection. Although several theories have been advanced to explain the mechanism of disinfection, the investigations of Bancroft and Richter have demonstrated that all types of chemical disinfectants affect bacteria in the same manner—by coagulating the colloids of the cell. The coagulation depends upon the absorption by the colloids of sufficient ions of the chemical substance. Furthermore they have shown that this coagulation may be of two types (1) reversible coagulation which inhibits the activity of bacteria but does not kill them (bacteriostatic action or antiseptics), and (2) irreversible coagulation

which is responsible for the death of the bacteria (bactericidal action or disinfection).

Copperized catgut in Germany. At the University of Bonn in Germany von Linden conducted some experiments with catgut sutures by saturating them with copper salts. She claimed that such treatment would completely sterilize the sutures destroying not only staphylococci but also tetanus spores and that sutures thus treated would keep sterile for weeks even when left exposed to air and dust. In the Municipal Clinic for Women in Stuttgart, Germany copperized catgut prepared by the von Linden method has been used for one and one half years by Balach, who reports that the antiseptic action of copperized catgut has been fully demonstrated by exhaustive bacteriological investigation, and that copperized catgut undoubtedly kills not only the pus cocci but also tetanus spores.

Copperized catgut in United States. Early in 1931 while examining sutures of various manufacturers, I found upon chemical analyses that the catgut sutures of three manufacturers in the United States contained appreciable quantities of copper. Bacteriological examination of these sutures by the Meleney and Chatfield (10) method indicated entire absence of growth.

In spite of the fact that von Linden and Balach reported that the bactericidal action of copper salts for catgut had been fully demonstrated I was not convinced that the American made copperized catgut sutures which I examined by the Meleney and Chatfield method were in any sense sterile because I found that their neutralizing solution of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate did not remove the copper salts from the sutures.

Neutralizing fluid for copper. Accordingly various chemical neutralizing solutions were prepared and a study was made of their power of removing copper salts from catgut. Finally after using many chemical solutions and making many tests, I found that the copper salts can be entirely dissolved and removed from the catgut by using a special neutralizing solution consisting of 5 per cent ammonium chloride with $\frac{1}{2}$ per cent ammonium hydroxide. The nature of the chemical reaction involves

the formation of a double salt of ammonia and copper which is water soluble. Repeated chemical analyses of copperized catgut before and after treatment with this neutralizing solution have demonstrated that the catgut sutures can be entirely freed of copper salts. The next step in this research study was thus apparent namely to subject copperized catgut to bacteriological tests in which this special neutralizing solution would be employed to remove the copper salts.

Bacteriological technique Therefore catgut ribbons made from fresh sheep intestines under ideal sanitary conditions were subjected to the sterilizing action of copper salts after the method recommended by von Linden (6). The copperized catgut ribbons were then made into finished sutures which were tubed in ethyl alcohol. Chemical analyses of these sutures showed appreciable quantities of copper present. In applying bacteriological tests the sutures were first transferred aseptically to tubes of sterile ammonium chloride with ammonium hydroxide and incubated 24 hours. Then they were again aseptically transferred to tubes of this sterile special neutralizing solution and again incubated 24 hours so that the sutures thus received two treatments in the ammonium chloride and ammonium hydroxide solution. Then the procedure adopted by Meleney and Chatfield (10) was followed wherein the sutures were transferred under aseptic technique into sterile distilled water and incubated 24 hours, and then into tubes containing a sterile solution of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate and incubated 24 hours. Finally the sutures were transferred aseptically into tubes of sterile Novy (11) culture medium. Those tubes which were incubated anaerobically were closed with a 'vaspar' seal as used and recommended by Hall. All culture medium tubes were incubated 15 days as recommended by Meleney and Chatfield (10).

Controls A complete set of controls is essential if the bacteriological test is to prove efficient and reliable. Meleney and Chatfield attempted to surround their standard test with every precaution and the controls which they specified are both important and necessary. However, in addition to the controls

TABLE I—COPPERIZED CATGUT

Prepared by von Linden's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
153	O 24 hrs.	O 24 hrs.	O 24 hrs.	C 24 hrs.	C 24 hrs.	O 24 hrs.
155	O	O	O	C 48 hrs.	C 6 days	O
156	O	O	O	O 13 days	O	O

Explanatory: O indicates bacterial growth, followed by the number of hours or days of the incubation period that elapsed before growth appeared. C means that there was entire absence of growth in the tube at end of 15 days incubation.

Series 153 consisted of control sutures not sterilized by heat but with any chemical. Series 155 and 156 were treated with copper salts treating these sutures bacteriologically; copper salts were best removed from the sutures by means of a special neutralizing fluid of ammonium chloride and ammonia in hydroxide, and then the sutures were put through the standard Meleney and Chatfield test.

which they described I have demonstrated that other controls are required if the test is to be adequately safeguarded. In applying the standard bacteriological test to the various lots of sutures examined throughout this entire investigation I used the following three additional controls which I think are essential: (1) Aerobic and anaerobic tubes of culture medium were planted with 10 cubic centimeters of each lot of distilled water and incubated 15 days to determine sterility of the water. (2) Aerobic and anaerobic tubes of culture medium were planted with 10 cubic centimeters of each lot of the neutralizing solutions and incubated 15 days to determine sterility of the solutions. (3) Two tubes of culture medium, not planted with catgut but sealed with a layer 2 centimeters thick from every batch made of the 'vaspar' mixture were incubated 15 days to determine sterility of the anaerobic seal.

The bacteriological tests on copperized catgut sutures brought to light both aerobic and anaerobic bacterial growth, the anaerobic growth appearing as late as the thirteenth day, as indicated in Table I.

Artificially infected copperized catgut The catgut, from which the sutures used in the foregoing experiment were made, represented the usual run of fresh sheep intestines from the abattoir. Therefore, in order definitely to determine the antibacterial action of copper salts, catgut ribbons were artificially infected

TABLE II.—ARTIFICIALLY INFECTED
COPPERIZED CATGUT

Raw catgut artificially infected with sporulating culture and treated with copper salts by von Linden's process

Serm. No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
9	Q 4 hrs.	Q 4 hrs.	Q 4 hrs.	Q 4 hrs.	Q 4 hrs.	Q 4 hrs.
96	O	O	O	O	O	O
97	O	O	O	Q 3 days	Q 6 days	Q 6 days

Explanation: Q indicates bacterial growth, followed by the number of hours or days of the incubation period that elapsed before growth appeared. O signifies that there was entire absence of growth in the tube at end of 5 days incubation.

Serm. 9 consists of control sutures not sterilized by heat nor with any chemical, but artificially infected with spores.

Serm. 96, although artificially infected with spores and treated with copper salts, showed entire absence of growth after test by the standard Meleney and Chatfield method; the neutralizing solution of 1 per cent sodium thiosulphate and sodium carbonate being used.

Serm. 97 was treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove the copper salts, as compared with the standard Meleney and Chatfield bacteriological technique. Anaerobic growth proves that copper salts start bacteriostatic action and not true germicidal action.

with a sporulating culture of *Bacillus subtilis* and *Bacillus sporogenes*. Some of these ribbons were not treated with any chemical but were immediately made into sutures for controls and tubed in ethyl alcohol. These control sutures were tested by the standard bacteriological method (10). The remaining infected ribbons were treated with copper salts according to von Linden's process and made into finished sutures which were tubed in ethyl alcohol. These artificially infected copperized sutures were divided into two lots, one of which was tested by the standard bacteriological method of Meleney and Chatfield using their neutralizing solution of sodium thiosulphate and sodium carbonate while the other lot was treated with the special neutralizing fluid of sterile ammonium chloride and ammonium hydroxide to remove the copper salts, and then was put through the standard bacteriological test (10). All of the control sutures (artificially infected but not treated with copper salts) promptly showed bacterial growth. All of the artificially infected copperized sutures tested by the standard method (10) and with the standard neutralizing fluid showed entire absence of growth but the lot of artificially infected copperized sutures that was treated with the

special neutralizing fluid and then was put through the standard bacteriological technique (10) showed *anaerobic bacterial growth* as indicated in Table II.

This experiment demonstrates that *copper salts do not sterilize catgut* but merely arrest bacterial growth through bacteriostatic action. It also proves that sodium thiosulphate and sodium carbonate will not remove copper salts from catgut and that if this solution be used as the sole neutralizing fluid falsely negative results will be obtained.

Commercial copperized catgut sutures. From the open market, I again purchased catgut sutures of the three American manufacturers whose products on previous analyses had been shown to contain copper salts. When analyzed chemically the product of manufacturer A was found to contain 0.34 per cent copper, that of manufacturer B contained 0.75 per cent copper while the sutures of manufacturer C contained 1.23 per cent copper. The tubing fluids used by these manufacturers consisted of alcohol denatured with a mercury compound. After removing the copper salts under aseptic technique with sterile ammonium chloride and ammonium hydroxide the sutures were subjected to the standard bacteriological test of Meleney and Chatfield. One hundred and fifty-six copperized catgut sutures from these three manufacturers were tested and 42 of them were found to contain living bacteria of the aerobic and anaerobic types. Thus approximately 27 per cent of these copperized catgut sutures were non-sterile, as indicated in Table III.

Von Linden's copperized catgut was purchased from manufacturer D in Germany and when analyzed chemically the sutures were found to contain approximately 3 per cent copper. After aseptically removing the copper salts by means of the ammonium chloride and ammonium hydroxide solution, the standard bacteriological test was applied. The results showed that 19 out of 36 (52 per cent) of the sutures contained living bacteria (see Table IV). These results confirm those obtained by Weichardt in the Erlangen Hygienic Institute as reported by Mehnert. Professor Weichardt believes that copperized catgut should be rejected because it lacks the

TABLE III—COPPERIZED CATGUT SUTURES

American manufacturers A B and C

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1 1 day	Tube 2 2 days	Tube 3 3 days	Tube 4 4 days	Tube 5 5 days	Tube 6 6 days	Tube 7 7 days	Tube 8 8 days	Tube 9 9 days	Tube 10 10 days	Tube 11 11 days	Tube 12 12 days
A Lot 1	G	O	O	O	O	O	G	O	O	O	O	O
A Lot 2	O	O	O	O	O	O	G	O	O	O	O	O
B Lot 1	O	O	O	O	O	O	G	48 hrs.	8 days	O	O	O
B Lot 2	G	C	G	G	G	O	G	G	G	G	O	O
B Lot 3	48 hrs.	48 hrs.	48 hrs.	1 day	13 days		48 hrs.	4 days	8 days	8 days		
B Lot 4	O	O	O	O	O	O	G	O	O	O	O	O
B Lot 5	G	O	O	O	O	O	11 days	O	O	O	O	O
B Lot 6	G	O	O	O	O	O	G	G	O	O	O	O
B Lot 7	13 days	O	O	O	O	O	11 days	13 days	O	O	O	O
C Lot 1	G	O	O	O	O	O	G	G	G	O	O	O
C Lot 2	3 days	O	O	O	O	O	9 days	13 days	13 days			
C Lot 3	G	O	O	O	O	O	G	G	G	O	O	O
C Lot 4	13 days	O	O	O	O	O	13 days	13 days	13 days			
C Lot 5	G	O	O	O	O	O	G	O	O	O	O	O
C Lot 6	48 hrs.	G	G	O	O	O	10 days	O	O	O	O	O
C Lot 7	G	O	O	O	O	O	G	C	G	G	O	O
C Lot 8	7 days	O	O	O	O	O	7 days	11 days	13 days	13 days		
C Lot 9	O	O	O	O	O	O	G	G	O	O	O	O
C Lot 10	O	O	O	O	O	O	13 days	13 days				
C Lot 11	O	O	O	O	O	O	G	G	O	O	O	O
C Lot 12	O	O	O	O	O	O	4 days	7 days				

Explanatory: G indicates bacterial growth, followed by the number of hours or days incubation that elapsed before growth appeared. O means entire absence of growth in the tube at end of 13 days incubation.

All sutures were treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove copper salts as a preliminary step to the standard Miley and Chetfield bacteriological method.

important quality of sterility and my views coincide with his on this subject

Bacteriostatic action of copper Vignati and Schnabel have shown that copper salts act on bacteria by coagulating the bacterial colloids an action similar to that on serum colloids. These investigators have demonstrated that copper salts, when added to a broth culture of *Bacillus coli*, constitute a mechanical obstacle to bacterial activity in that the chemical compound isolates the bacteria from their surroundings and deprives them of nutritional support, thus preventing their multiplication. They have also shown that the bacteria may be reactivated by means of a neutralizing solution capable of re-dissolving the copper coagulum, which is thus proved to be directly reversible.

From a study of the results of my researches on copperized catgut described in this paper,

it is evident that when catgut sutures are treated with copper salts an arrested development of the bacteria within the catgut is brought about through the bacteriostatic action of the copper. Apparently, the copper salts act on the bacterial colloids in such a manner that, even in the presence of a suitable culture medium, the bacteria are deprived of their nutritional support. It is equally evident from my experiments that the removal of the copper salts from the catgut by means of an effective neutralizing fluid consisting of ammonium chloride and ammonium hydroxide, reactivates the bacteria, so that, when nutritional support is provided in the form of a proper culture medium bacterial growth occurs.

Reaction of tissues to copperized catgut While the above bacteriological tests on copperized catgut were in progress some plain

TABLE IV.—COPPERIZED CATGUT SUTURES

Made in Germany

Manufacture	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
D Lot	G 24 hrs	O 24 hrs	G 24 hrs	G 24 hrs	O 9 days	O	O days	G 12 days	G 12 days	O	O	O
P Lot	G 24 hrs	G 24 hrs	O 24 hrs	G 24 hrs	O	O	O days	O days	O	O	O	O
P Lot 2	G 24 hrs	G 24 hrs	G 24 hrs	O	O	O	O 1 day	O 11 days	O	O	O	O

Explanation: G indicates bacterial growth, followed by the number of hours' or days' incubation that elapsed before growth appeared. O means no growth observed in the tube at end of 3 days' incubation.

All sutures were treated with the special neutralizing fluid of ammonium chloride and ammonium hydroxide to remove copper salts before being tested by the standard McLeary and Chatfield bacteriological method.

(untreated) catgut sutures sterilized by heat and some of a similar size treated with copper salts after the method of von Landen and also subjected to heat sterilization were embedded in animal tissues for the purpose of determining the relative degree of irritation produced in the tissues by the plain and by the copperized sutures. Both kinds of sutures were prepared from the same batch of raw catgut in order to assure uniform raw material.

Each of these two kinds of sutures was woven through the serosal layer of a rabbit's stomach under aseptic technique. Four rabbits were used and they were sacrificed at 5 day intervals. After noting the gross pathological appearance of the removed stomachs, illustrative pieces of tissue containing the suture were placed in 10 per cent formaldehyde and histological sections made and mounted on microscopic slides. Simple haematoxylin eosin stain as well as the fibrous tissue differential stain of van Gieson, was used.

A study of the histological appearance of the tissues after the sutures had been embedded for 5 days 10 days 15 days, and 20 days, showed that the copperized catgut was less readily absorbed than the plain untreated catgut sutures. Also the copperized sutures were definitely more irritating as indicated by the greater cellular response which they produced as compared to the plain untreated sutures.

Peppermint oil catgut sutures in England. A very novel and ingenious method adopted for the chemical sterilization of catgut sutures was reported by Porritt. In this method, the

raw catgut is first soaked 6 hours in a solution of sodium bichromate phenol and glycerin then dried and placed in hermetically closed containers filled with peppermint oil in ethyl alcohol (1 to 10). These containers are immersed in a water bath at 60 degrees C for 2 hours on 2 successive days. The sutures are then removed from the containers and preserved in 1 to 20 phenol in ethyl alcohol.

In order to demonstrate the efficiency of his method, Porritt artificially infected some raw catgut with *Bacillus subtilis*, *Bacillus sporogenes*, *Bacillus tetanus* and *Bacillus welchii* the infected sutures were then put through his peppermint oil process for chemical sterilization and the peppermint oil and chromic acid were removed by distillation with ether and water in a sterile Soxhlet apparatus. For controls, another lot of catgut was similarly infected and then subjected to the distillation process the sterilization process with peppermint oil being omitted. Both lots were then subjected to bacteriological tests (technique not described). He reports that all culture tubes containing the peppermint oil treated sutures showed entire absence of bacterial growth while the tubes of the control sutures all contained a heavy growth of bacteria corresponding to the species used for artificially infecting the catgut.

Bacteriological tests of peppermint oil catgut. Owing to the fact that Porritt's peppermint oil catgut sutures are made and used exclusively in a British hospital they are not for sale in the open market in England. However I endeavored to secure some of these sutures direct from Mr. Porritt and to obtain

details of his bacteriological tests but without success. Therefore, in order to test the value of peppermint oil as a sterilizing agent catgut sutures were prepared under ideal sanitary conditions from the ordinary run of fresh sheep intestines at the abattoir and sterilized by Porritt's complete peppermint oil process as outlined. The sutures were then tested bacteriologically by the standard method of Meleney and Chatfield. Five lots of controls were also tested as follows: (a) In order to remove the possibility of all chemicals used in the peppermint oil process from acting as sterilizing agents raw catgut was subjected to the peppermint oil process and then all chemicals were extracted with ether and water in a sterile Soxhlet apparatus the catgut being placed in sterile thimbles. (b) To exclude phenol in the tubing fluid as the possible sterilizing agent some raw catgut not subjected to the peppermint oil or other treatment was stored for 72 hours in 1.20 phenol in ethyl alcohol in hermetically sealed tubes. (c) To rule out the peppermint oil as the possible sterilizing agent raw catgut, after being subjected to Porritt's peppermint oil process was extracted with ether to remove the peppermint oil, the catgut sutures being placed in sterile thimbles and no tubing fluid used. (d) To exclude sodium bichromate as a possible sterilizing agent raw catgut was soaked 6 hours in Porritt's solution of sodium bichromate, phenol, and glycerin but no further treatment was given the sutures being transferred aseptically from this solution to the bacteriological testing fluids. (e) As an additional control raw catgut strings (untreated) were also tested.

The bacteriological tests were applied in accordance with the technique previously referred to as the standard method of Meleney and Chatfield. All culture tubes (aerobic as well as anaerobic) containing the peppermint oil treated sutures as well as those containing the controls (a, b, c, d and e) showed bacterial growth within 48 hours, thereby demonstrating that catgut sutures prepared by the peppermint oil method of Porritt are non-sterile. This experiment was repeated with another lot of raw catgut, but the results were the same (see Table V).

TABLE V.—PEPPERMINT OIL CATGUT

Porritt's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
109 (a)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 48 hrs.	G 48 hrs.
110 (b)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 48 hrs.
111 (c)	G 24 hrs.	G 24 hrs.	G 24 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
120 (d)	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
121 (e)	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
108	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.
118	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.	G 48 hrs.

Explanatory: G indicates bacterial growth, followed by the number of hours or days incubation that elapsed before growth appeared.

Series 109, 110, 1, 120 and 121 are control lot and correspond to controls (a), (b), (c), (d) and (e) described in the text.

Series 108 and series 118 comprised sutures prepared from two different lots of raw catgut. Both series were sterilized by Porritt's process. Sutures in all of these series were tested by the standard Meleney and Chatfield method.

Artificially infected peppermint oil catgut

While these results demonstrated that the peppermint oil process will not sterilize even the ordinary run of raw catgut and the method is therefore inefficient and unsafe because the peppermint oil sutures contain living bacteria yet it seemed advisable to prove conclusively the presence or absence of any germicidal properties of peppermint oil for catgut by treating some artificially infected catgut by the Porritt method. Accordingly catgut ribbons were infected with a sporulating culture of *Bacillus subtilis* and *Bacillus sporogenes*. Then the ribbons were made into finished sutures which were divided into two lots one of which was subjected to Porritt's peppermint oil process while the other lot was left untreated for control. The results of bacteriological tests on the two lots are shown in Table VI and these results prove beyond all question that Porritt's method of chemically sterilizing catgut with peppermint oil is unsafe.

Mercury compounds for sterilizing catgut A large number of experiments was carried out by subjecting catgut ribbons raw catgut strings, as well as artificially infected catgut, to chemical sterilization with the various mer-

TABLE VI.—ARTIFICIALLY INFECTED
PEPPERMINT OIL CATGUT

Raw catgut artificially infected with sporulating culture and treated by Porritt's process

Series No.	Aerobic tests			Anaerobic tests		
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6
24	G hrs.	G hrs.	G hrs.	G hrs.	G hrs.	G hrs.
25	G hrs.	G hrs.	G hrs.	G hrs.	G hrs.	G hrs.

Explanatory: G indicates bacterial growth, followed by the number of hours or days' incubation that elapsed before growth appeared.

Series 24 consisted of control sutures artificially infected but not treated with peppermint oil.

Series 25, after being artificially infected, was put through Porritt's process with peppermint oil.

All sutures were tested by the standard Meleney and Chatfield method.

cury compounds previously mentioned. The results of bacteriological tests of such chemically sterilized sutures showed however that none of these mercury compounds will effectively sterilize catgut.

During the year 1931 in connection with my study of mercury compounds, I purchased in the open market, at intervals of a few months, several lots of catgut sutures of American manufacturer E. Chemical analyses always revealed an appreciable amount of a mercury compound in the sutures and my bacteriological examinations of this manufacturer's sutures showed the presence of living bacteria in at least 2 specimens from every batch of twelve sutures which I tested by the Meleney and Chatfield method. These results were in conformity with those which I obtained when testing the experimental lots of sutures sterilized chemically with the various mercury compounds. However chemical analyses of this manufacturer's sutures purchased early in 1932 showed them to be heavily impregnated with a mercury compound and when such sutures were examined bacteriologically by the standard test of Meleney and Chatfield, entire absence of bacterial growth was indicated.

Upon further investigation I found that the amount of the mercury compound present in the sutures purchased in 1932 was so large (3.5 per cent) that the neutralizing fluid of 1 per cent sodium thiosulphate and 1 per cent sodium carbonate used in the standard Meleney and Chatfield test would not remove all

of the mercury compound from the sutures. Accordingly a 5 per cent solution of sodium thiosulphate was tried for this purpose but it was found that even this strength would not remove all of the mercury compound from the sutures. Further research demonstrated that this could be attained by means of a neutralizing fluid consisting of 10 per cent solution of sodium thiosulphate. Therefore, as the next logical procedure, some sutures of manufacturer E purchased in 1932 were tested bacteriologically by first transferring them aseptically to and incubating them in, a sterile neutralizing solution of 10 per cent sodium thiosulphate for 24 hours and then by putting them through the standard Meleney and Chatfield technique. The results of these tests showed the presence of living bacteria in the sutures.

Two additional lots of sutures of manufacturer E were purchased. One lot consisted of plain catgut sutures while the other lot was chromic catgut. Chemical analyses of these sutures revealed the presence of a large amount of a mercury compound (mercuric iodide). Twelve sutures of each lot were examined bacteriologically by the standard Meleney and Chatfield method, and the results indicated entire absence of bacterial growth (see Table VII). Twelve other sutures of these same lots and bearing the same batch numbers were first transferred under aseptic conditions to and incubated for 24 hours in, the neutralizing solution of 10 per cent sodium thiosulphate. Then these sutures were put through the standard bacteriological technique of Meleney and Chatfield, and all twelve sutures of one lot (plain) and eight sutures of the other lot (chromic) were found to contain living bacteria (see Table VIII). Hence it is evident that the mercury compound present in such large amount in these sutures exerted a bacteriostatic action, thereby arresting development of the bacteria within the catgut. Likewise, it is apparent from these experiments that removal of all of the mercury compound from the sutures, by means of a neutralizing solution of 10 per cent sodium thiosulphate, reactivates the bacteria which are thus enabled to grow in the culture medium.

TABLE VII—MERCURIALIZED CATGUT SUTURES

Tested by standard Meleney and Chatfield method

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
E Lot 1	O	O	O	O	O	O	O	O	O	O	O	O
E Lot 2	O	O	O	O	O	O	O	O	O	O	O	O

Explanatory: O means entire absence of growth in the tube at end of 14 days incubation.

Sutures comprising Lot 1 were plain catgut, while those of Lot 2 were chemically catgut.

Chemical analyses showed that these sutures contained 3½ per cent of mercury also that all of the soluble mercury was not removed from the sutures by the neutralizing solution of 10 per cent sodium thiosulphate and 1 per cent sodium bicarbonate used as part of the standard Meleney and Chatfield method.

TABLE VIII—MERCURIALIZED CATGUT SUTURES

Tested by standard Meleney and Chatfield method, but a special neutralizing solution of 10 per cent sodium thiosulphate was used as a preliminary step

Manufacturer	Aerobic tests						Anaerobic tests					
	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 6	Tube 7	Tube 8	Tube 9	Tube 10	Tube 11	Tube 12
E Lot 1	G 4 days	G 4 days	G 4 days	G 5 days	G 12 days	G 5 days	G 7 days	G 9 days	G 1 days	G 13 days	G 13 days	G 13 days
E Lot 2	G 7 days	G 1 days	G days	G 1 days	O	O	G 11 days	G 13 days	G 1 days	G 13 days	O	O

Explanatory: G indicates bacterial growth followed by the number of hours or days incubation that elapsed before growth appeared. O means entire absence of growth in the tube at end of 14 days incubation.

Sutures comprising Lot 1 were plain catgut, while those of Lot 2 were chemically catgut.

These sutures were taken from the same lots and bore the same batch numbers as the sutures used for the tests shown in Table VII. Before being put through the standard Meleney and Chatfield technique these sutures were transferred aseptically to tubes of sterile 10 per cent sodium thiosulphate and incubated for 4 hours to remove the large amount of mercury (3½ per cent).

These results serve to emphasize the fact that falsely negative findings may follow the use of the standard Meleney and Chatfield test unless a close check up is always made first, by subjecting some of the sutures under examination to careful chemical analyses to determine the nature and quantity of any chemical compound that may be present, and second by using in connection with the bacteriological tests a suitable neutralizing fluid which will dissolve and remove whatever chemical compound is found to be present.

In order to detect the presence of bacteria in catgut which has been subjected to the chemical action of such large amounts of a mercury compound as are being used by American manufacturer E, the use of 10 per cent sodium thiosulphate for a neutralizing solution is recommended. This solution should be used as a preliminary step to the standard bacteriological technique of Meleney and Chatfield, so that the 10 per cent solution of sodium thiosulphate will be removed from the sutures by the distilled water which con-

stitutes the first step of the standard Meleney and Chatfield method and thus will not be carried over into the culture medium where it might inhibit bacterial growth.

Other chemical compounds for sterilizing catgut. The sterilizing action of each of the other chemical compounds included in this study was systematically investigated. A careful study was made of the effect of wide variations of the several factors involved in the application of the chemical to the catgut, such for example, as the strength of the solutions, the duration of the chemical sterilizing treatment (time of contact) the hydrogen ion concentration and temperature of the solutions, buffering of solutions, as well as combinations of the chemicals. Moreover, these studies included the effect of the sterilizing action of the chemical compounds on catgut ribbons, raw catgut strings, and artificially infected catgut.

Before attempting to evaluate the possible merits of any of the chemicals under investigation, a large number of sutures prepared in

various ways was subjected to the sterilizing action of the chemical under a wide variety of conditions and the sutures were then tested bacteriologically by the standard method of Meleney and Chatfield.

In some of the early studies of this investigation the bacteriological results were encouraging. Thus, the chemical compounds which seemed to give promise of exerting a true sterilizing action on catgut were metaphen, copper sulphate diacetoxymercurothocresol, and iodine plus potassium iodide. However if the bacteriological results indicated that some particular chemical apparently exhibited effective germicidal properties on some lots of catgut ribbons or of raw catgut strings, the experiment was repeated under precisely the same conditions several additional lots of catgut being used with the view of confirming the results. Invariably the bacteriological results of these confirming experiments failed to establish the reliability and effectiveness of the chemical as a sterilizing agent. But if the results still appeared to hold out promise of ultimate success and therefore to warrant still further experiments, artificially infected catgut was also subjected to the sterilizing treatment with that particular chemical compound.

Although several of the chemical compounds included in this study have been reported by various authors to possess germicidal properties for various surgical, medical or laboratory purposes, *none of them proved to be efficient and reliable agents for the chemical sterilization of catgut*. Owing to the large number of tests that were applied the tabulated results obtained with each of the various chemical compounds studied would occupy a very large amount of valuable space. Hence, it has been necessary to omit tables showing results with chemicals other than copper sulphate peppermint oil and mercuric oxide. The reason for including detailed and tabulated results obtained with these three chemicals must be apparent from the foregoing information relating to them.

Chemical sterilization inefficient Thus far the chemical compounds which have been tried out in an attempt uniformly and effectively to destroy the bacteria commonly pres-

ent in raw catgut have given disappointing and unreliable results. Most chemicals have had an especially weak action upon the spore-forming bacteria which are often found in the innermost portions of the gut.

During the course of this investigation, the sterilizing action of each of the 27 chemical compounds studied was applied to a large number of lots of catgut sutures prepared from fresh sheep intestines under ideal sanitary conditions also to many lots of artificially infected catgut. None of the chemicals was found to have reliable or uniform sterilizing action on catgut and in no case did all lots of sutures, sterilized with any one of the chemicals or a combination of the chemicals prove to be entirely free from living bacteria. Therefore the net results indicate the fallacy of the chemical method of sterilizing catgut, so far as the chemical compounds included in this study are concerned.

This research work involved bacteriological studies of 334 experimental lots of catgut comprising several thousand sutures, together with 154 commercial lots embracing 1134 catgut sutures. The results of this investigation have proved conclusively that *chemical sterilization of surgical catgut as employed at present is inefficient and unreliable*. Hence it becomes evident that chemically sterilized catgut sutures are unsafe because their sterility is uncertain unless of course some chemical not included in this study or which may be developed in the future proves to be an effective sterilizing agent for catgut.

Heat sterilization effective and reliable Unlike chemical disinfection the efficiency of sterilization of catgut sutures by heat does not depend upon the absorption of ions. On the contrary heat of an effective degree penetrates all parts of the cell colloid of any bacteria that may be within the catgut, and thus devitalizes the essential matter of the bacterial cell.

In my studies of the chemical sterilization of surgical catgut each experiment was controlled by subjecting to heat sterilization a duplicate lot of catgut sutures that had been treated with the particular chemical being studied. In every instance, the heat-sterilized sutures came through the bacteriological tests

with entire absence of bacterial growth, thus proving that *heat sterilization properly controlled is the only safe and positive method for sterilizing surgical catgut sutures*. Moreover there was no impairment of tensile strength as a result of the heat treatment thus showing that with sufficient care effective heat sterilization can be applied without altering the physical properties of the catgut.

SUMMARY

In this investigation which extended over a period of 2½ years several thousand catgut sutures were prepared from 334 lots of catgut. Twenty seven different chemical compounds were used for treating these various lots of catgut under a wide variety of conditions in an attempt to bring about chemical sterilization, the various chemical treatments having been applied to catgut ribbons to raw catgut strings, as well as to artificially infected catgut.

The chemical compounds used in this research study included mercurochrome mercuraphen merthiolate metaphen potassium mercuric iodide hexylresorcinol tribrommercurinol orthophenylphenate ethylhydrocuprene tribrombetanaphthal copper cyanide copper chloride copper sulphate copper sulphate plus methylene blue zinc sulphate peppermint oil oil of tea tree (*Melaleuca alternifolia*) hydrogen peroxide malachite green pyridium iodine iodine plus potassium iodide myodine parachlorometacresol diacet oxymercurothochresol parachlorophenol and chlorthymol ester.

In applying the chemical sterilization processes the effect of wide variations in the several factors involved was studied including the strength of the chemical solutions the duration of the chemical sterilizing treatment, the hydrogen ion concentration and temperature of the solutions buffering of solutions, and combinations of the chemicals. Duplicates of each lot of catgut that received chemical sterilization treatment were also subjected to heat sterilization as a control.

In addition to the large number of experimental lots of catgut which were subjected to the sterilizing action of the various chemical compounds before mentioned, this investiga-

tion also included a study of the sterility of 154 commercial lots purchased from the open market and comprising 1134 catgut sutures.

Throughout these experiments the standard bacteriological test, devised and proposed by Meleney and Chatfield was used for determining the sterility of catgut, but 3 additional controls were used and are recommended as essential for safeguarding the reliability and efficiency of the test.

The results of my experiments with copperized catgut sutures herein described have demonstrated that copper salts applied to catgut by the von Linden method do not effectively sterilize catgut. These findings confirm those of Weichardt as reported by Mehnert (8). Moreover, my copperized catgut experiments have shown that copper salts exert a bacteriostatic action on the bacteria in catgut, for when the copper is removed with a suitable neutralizing fluid the bacteria become reactivated.

It was found that the 1 per cent solution of sodium thiosulphate and sodium carbonate used by Meleney and Chatfield in their standard test for neutralizing mercury compounds and iodine will not remove copper salts from catgut sutures. A solution consisting of 5 per cent ammonium chloride and ½ per cent ammonium hydroxide was found to be an effective neutralizing agent for dissolving and removing copper salts from catgut.

Copperized catgut sutures embedded in animal tissues were less readily absorbed and were definitely more irritating than plain (untreated) catgut sutures.

Chemical analyses of catgut sutures of three American manufacturers and of one German manufacturer revealed appreciable quantities of copper. Bacteriological examinations showed the presence of living bacteria in 42 of 156 (approximately 27 per cent) of the copperized sutures of the 3 American manufacturers, and in 19 of 36 (52 per cent) of the copperized sutures of German make (von Linden process).

Peppermint oil catgut sutures were demonstrated by repeated bacteriological tests to be 100 per cent non sterile. This method of sterilizing catgut, recommended by Porritt, not only fails to sterilize artificially infected cat-

gut but even the ordinary run of raw catgut made from fresh sheep intestines and processed under ideal sanitary conditions.

Chemical analyses of catgut sutures marketed in 1932 by an American manufacturer revealed a large amount of a mercury compound, and when such sutures were examined bacteriologically by the standard test of Meleney and Chatfield entire absence of bacterial growth was indicated. The large amount (3.5 per cent) of the mercury compound could not be removed from the sutures by the neutralizing solution of 1 per cent sodium thiosulphate and sodium carbonate used in the Meleney and Chatfield test, but it was found that a neutralizing fluid of 10 per cent sodium thiosulphate effectively removes the mercury compound from the sutures. When sutures of this manufacturer were tested bacteriologically by first incubating them for 24 hours in a sterile 10 per cent solution of sodium thiosulphate and then by putting them through the standard Meleney and Chatfield technique the results showed the presence of living bacteria in the sutures.

Bacteriological tests, applied to commercial catgut sutures containing a large amount of a mercury compound have shown that arrested development of bacteria within the catgut is brought about through the bacteriostatic action of the mercury compound. These tests have also proved that removal of the mercury compound from the sutures by means of a suitable neutralizing fluid reactivates the bacteria which then are able to grow in the culture medium.

None of the 27 chemical compounds studied in this investigation was found to have reliable or uniform sterilizing action on catgut for in no case did all lots of sutures sterilized with any one of the chemicals or a combination of the chemicals, prove to be entirely free from living bacteria. However every one of the duplicate lots of sutures which were subjected to heat sterilization showed entire absence of bacterial growth.

CONCLUSIONS

1. When applying the standard bacteriological test of Meleney and Chatfield for determining the sterility of surgical catgut

sutures, the details of the chemical treatment to which they have been subjected must be known or else careful qualitative and quantitative chemical analyses of some of the sutures must first be made to ascertain the nature and amount of the chemical compound used to impregnate the sutures.

2. A suitable neutralizing fluid must be devised and used to dissolve and remove the particular chemical substance found in the catgut sutures before applying the standard bacteriological test.

3. The necessity of incubating commercial catgut sutures for at least 15 days is clearly indicated by the results of bacteriological tests shown in Tables III and VIII wherein the greatest number of growths occurred on the thirteenth day and some growths appeared even as late as the fifteenth day (Table III). This confirms the findings of Meleney and Chatfield who reported the appearance of the largest number of growths on the thirteenth day and who recommended an incubation period of 15 days as a margin of safety.

4. When used with the three additional and essential controls herein described, and when used in conjunction with suitable neutralizing fluids for dissolving and removing the chemical compound with which the sutures may be impregnated the standard bacteriological test proposed by Meleney and Chatfield seems to be an efficient and reliable test for the sterility of surgical catgut sutures.

5. The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable.

6. Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures.

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EXPERIMENTAL SHOCK. THE EFFECT OF BLEEDING AFTER REDUCTION OF THE BLOOD PRESSURE BY VARIOUS METHODS¹

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IN clinical surgery the effects of trauma or an operation are estimable by observations on the pulse, blood pressure, respiration, reflexes, color of skin and mucous membranes and occasionally by other factors. Of these the blood pressure is commonly held the most important single index and is frequently the only finding given much consideration. But since the blood pressure is maintained by several factors (ventricular contraction, peripheral resistance, blood volume and viscosity), and may be reduced by alteration of any of these, the significance of a lowered pressure is very variable. It is therefore not a reliable guide to the condition of the patient without regard for the cause of its depression and for the other means of evaluating its importance. Thus a low pressure produced by hemorrhage usually indicates a serious state of the circulation in which further loss of blood or an operation is badly tolerated, but an equally low pressure occurring as a result of spinal anesthesia may have no such significance, and an operation may be completed without undue risk. Hadenfeldt states from a study of a large series of spinal anesthetics that the effect of loss of blood is no more serious under spinal than under general anesthesia. Burch, Harrison and Blalock, however, reached an opposite conclusion from animal experiments. It has been observed in

this and other clinics that the blood pressure may fall considerably with a concurrent slowing of the pulse during upper abdominal operations such as cholecystectomy or gastric resection without apparent cause and rapidly return to normal levels upon closure of the abdomen with no noticeable after-effects. Hadenfeldt assumes this effect to be due to traction on the vagus nerve below the diaphragm with reflex cardiac inhibition.

In an endeavor to test experimentally the value of blood pressure readings as an index of the condition of the circulation and to evaluate the seriousness of the blood pressure fall of spinal anesthesia, the blood pressure was lowered in dogs to 'shock levels' by nine different methods and the effect of bleeding the animals to death was studied. Certain observations made in the course of these experiments have a bearing on the general problem of the mechanism of traumatic shock, as to whether a histamine like toxin is liberated from the damaged tissues (Cannon, 5, and Cannon and Bayliss, 6), or whether there is sufficient local loss of fluid to account for the fall of blood pressure (Blalock, 2, and Parsons and Phemister, 16). In addition it was attempted in several animals without success to reduplicate the fall of blood pressure which results in man after upper abdominal operations.

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EXPERIMENTAL METHODS

The blood pressure was reduced in a series of 50 dogs to levels usually between 50 and 70 millimeters of mercury by the following methods: hyperventilation, anaphylactic shock, histamine administration, spinal cord section, spinal anesthesia, trauma to a limb, hemorrhage, plasmapheresis, and intestinal manipulation. The animals were bled to death in most experiments approximately 1 hour after the initiation of the procedure, and the amount of blood obtainable was measured. Anesthesia was by ether or sodium-barbital. Blood counts were made in 37 cases before and after the depression of the blood pressure. Bleeding was by a large carotid cannula, the animal being left in the horizontal position and the cannula kept free of clots, the bleeding volume thus obtained is presumed to be an approximate index of the circulating blood volume and will be described in the remainder of this paper as a percentage of the calculated blood volume (one-thirtieth of the body weight). The experiments and the results obtained will be described in groups according to the method used to depress the blood pressure.

1. CONTROL SERIES

Twenty additional dogs were merely anesthetized, 10 with ether and 10 with sodium-barbital, and bled at the end of an hour. The results are contained in Table I and indicate that while there is a considerable individual variation of the bleeding volume there is no significant difference in this respect between the two anesthetic agents. The individual variations are probably due to (1) mechanical errors in bleeding, (2) individual characteristics, notably the proportion of fat to the other tissues of the animal, and (3) differences in the water content of the tissues and the alimentary tract. The percentages of the calculated blood volume obtained from the normal animals varied from 34 to 82 per cent, and averaged 58.6 per cent.

2. HYPERVENTILATION

Henderson (9) as early as 1905 described the depression of the blood pressure in apnea, and offered this phenomenon as an initiating agent of surgical shock. Recent evidence (McDowell) indicates that apnea has a dual effect on the circulation, a central vasodilatation which usually predominates, and a local constriction of smaller and more peripheral vessels.

a. Hyperventilation by intratracheal insufflation. Six dogs anesthetized by sodium barbital were each hyperventilated by connection of a cannula in the trachea to two Palmer respiration pumps, arranged so as alternately to pump in and suck out the same volume of air and operated at approximately 140 revolutions per minute. Due to temperature changes, this method of artificial respiration was found to result in slightly increased intrapulmonary pressure; this effect was minimized by connecting a T-tube in the system to permit communication with the atmospheric air. A rapid fall of blood pressure

occurred in each case, and at the end of approximately 1 hour while the artificial respiration was continued the amounts bled were from 21 to 41.5 per cent of the calculated blood volume, the average being 33.7 per cent. Blood counts showed no constant or marked change.

b. Hyperventilation by external alternating pressure. From observations made on the dogs of Series 2a and other animals, it was concluded that in hyperventilation by the intratracheal method there are certain factors capable of causing a blood pressure fall independent of the degree of apnea, viz. mechanical impairment of the pulmonary circulation, as noted by Janeway and Ewing, and reflex vasodilatation from increased intrapulmonary and intrabronchial pressure (Johnson and Luckhardt). Therefore a somewhat more physiological method of artificial hyperrespiration was devised (17) in which the animal was enclosed in a metal cylinder with its head projecting in the manner of the Drinker respirator and alternately positive and negative air pressure applied to the exterior of the body by connection to two Palmer pumps operated synchronously at approximately 115 revolutions per minute. When this method was applied to 5 dogs anesthetized with sodium barbital, the blood pressure fell slightly immediately, recovered to nearly the normal level, then slowly fell to levels of from 52 to 69 millimeters of mercury. The bleeding volumes at these levels, while the artificial respiration was continued, were from 50 to 67 per cent of the calculated blood volume, averaging 56.2 per cent. This average is relatively much higher than that obtained in lowered pressures from intratracheal insufflation, even when the difference in terminal pressures is considered, this is a further indication that in the intratracheal method there is actual obstruction to the pulmonary circulation, while in the external pressure method the effects are more purely due to apnea with secondary vasodilatation. For this reason, although the results of both series of experiments are included in Table II only those of series 2b will be considered in the discussion to follow. It must also be noted that the external alternations of pressure would minimize any stagnation of blood in the veins, as has been suggested may occur in apnea (Henderson, 10) but in these experiments a considerable fall of pressure occurred in the absence of such stagnation.

3. ANAPHYLAXIS

A fall of blood pressure occurs in dogs during "anaphylactic shock," the mechanism of which is not entirely clear but is presumably the same as with the analogous "histamine shock," i.e., by direct action on the capillaries (Soliman).

Eleven dogs were sensitized to pig's blood, and when under ether anesthesia small amounts of the same blood were injected intravenously anaphylactic shock of a satisfactory degree developed in 5 animals. In these the blood pressure fell rapidly to low levels, with a tendency to recover in some cases.

TABLE I—BLEEDING VOLUMES OF NORMAL DOGS ANESTHETIZED FOR ONE HOUR

(a) Under ether anesthesia		(b) Under sodium barbital	
Dog No.	Bled, per cent of the calculated blood volume	Dog No.	Bled, per cent of the calculated blood volume
417	57.5	410	67.8
417b	53.1	413	53.6
418	64.5	414	52.4
445	50.3	415	57.0
494f	53.9	410	67.0
446	67.2	466a	53.3
510*	47.5	477	75.1
511	60.3	453A	61.0
512	51.1	452	56.3
TR	65.6	45	47.1
Average	51.8	Average	62.4

Average of 20 dogs 53.6 per cent of the calculated blood volume

*Fat dog. †Very fat dog

The time interval was necessarily short in this series and the severity of the reaction was very variable. On bleeding from 20 to 65 per cent of the calculated blood volume was obtained the average being 51 per cent (Table III). Erythrocyte counts showed no constant change.

4 HISTAMINE ADMINISTRATION

The effects of histamine on the circulation are complex. In a few species it raises the blood pressure while in dogs and most other animals it produces an extensive fall of blood pressure apparently by direct action on the capillaries (Dale and Richards), the condition being similar to surgical shock (Mellanby).

Histamine (ergamin acid phosphate) was given in aqueous solution by a continuous intravenous drip in 5 dogs, and subcutaneously in 1 dog No. 487. By both methods the blood pressure slowly fell to the desired levels. Four of the animals were anesthetized with ether, 2 with sodium barbital. The amounts bled were from 36 to 66 per cent of the calculated blood volume and the average was 50.5 per cent (Table IV). Blood counts were made in 5 cases. In 3 there was no significant change; in 2 there was a slight increase in the red cells.

5 SPINAL CORD SECTION

The spinal cord was cut after preliminary laminectomy in the region of the first thoracic segment, in 6 dogs anesthetized with ether. There was usually little bleeding during the laminectomy, and that incidental to cutting the cord was minimized by immediately packing the wound. The procedure thus represents the combination of a small operation with spinal cord section. The blood pressure reaction to

TABLE II—HYPERVENTILATION

(a) By Intratracheal Insufflation

Experiment	Anesthetic	Blood pressure		Time minutes	Terminal bleed, per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
300	S-B	153	55	37	31
301	S-B	136	54	67	41.5
306	S-B	145	51	83	31
305	S-B	145	51	61	30
401	S-B	170	67	83	35
403	S-B	172	60	67	35
Average			57	63	32.7

(b) By External Alternating Pressure

Experiment	Anesthetic	Blood pressure		Time minutes	Terminal bleeding volume per cent of the calculated blood volume
		At beginning, mm. Hg.	At end, mm. Hg.		
410	S-B	146	54	80	31
411	S-B	175	63	90	35
415	S-B	156	63	113	67
416	S-B	153	60	110	55
440	S-B	103	61	83	30
Average			61	97	50.2

the section was somewhat variable but there was typically an immediate rise due to transient stimulation of the vasoconstrictor nerves, then a gradual fall in 25 to 30 minutes to levels of from 52 to 68 millimeters of mercury due to interruption of the vasomotor pathways. The amounts bled were from 41 to 51 per cent of the calculated blood volume averaging 48 per cent (Table V). There was a slight decrease in the erythrocyte count in four of five cases.

6 HIGH SPINAL ANESTHESIA

A 3 per cent solution of procaine in physiological salt solution was injected intrathecally in the upper lumbar region in 4 dogs after laminectomy and in 2 (Nos. 385, 417) without laminectomy. All were under light ether anesthesia. Sufficient procaine was slowly injected to produce relaxation of the entire chest wall and in some a slight slowing of the respirations. The blood pressure fell gradually and continuously as the anesthesia spread upward presumably by interference with conduction of vasomotor impulses in the efferent spinal nerves. From 38 to 55 per cent of the calculated blood volume was obtained, the average being 44 per cent (Table VI). No blood counts were made in this series.

7 TRAUMA TO AN EXTREMITY

Cannon and Bayliss (6) concluded that the fall of blood pressure after trauma to an extremity was due to the liberation of a toxic histamine like substance

TABLE III.—ANAPHYLAXIS

Experiment	Anesthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
377	E		45	20	64
375	E	120	40		37
338	E	120	60		63
330	E	30	45	20	48
338	E	3	25	5	20
Average			43	18	37

TABLE V.—SPINAL CORD SECTION

Experiment	Anesthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
298	E	174	52	15	20
340	E	130	60	60	20
34	E	50	65	60	51
34	E	54	54	65	41
344	E	128	52	45	52
345b	E	20	28	20	47
Average			29	3	48

TABLE IV.—HISTAMINE ADMINISTRATION

Experiment	Anesthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
263	E	120	54	74	47
264	E	33	28	60	66
265	E	172	62	28	20
267	E	26	18	63	20
499	S-B		47		54
487	S-B	3	43	4	10.5
Average			34	34	20.1

from the injured tissues, with generalized vasodilatation and increased capillary permeability. Later observations by Blalock (2) and Phenister and Parsons (16) have shown that there is sufficient local loss of fluid into the traumatized area to account entirely for the blood pressure fall.

In the present experiments, trauma was applied to one or both hind limbs of 4 dogs by many blows with a padded hammer: sodium barbital was the anesthetic in all cases. The blood pressure usually fell but slightly with the first hammering, and more sharply with the successive hammerings; this is similar to the effect of repeated bleedings, as will be described. Blood counts showed a diminution in all cases. The bleeding volumes were from 23 to 26.5 per cent of the calculated blood volume, averaging 24.6 per cent (Table VII).

8. HÆMORRHAGE

In 7 dogs small amounts of blood were repeatedly withdrawn from a carotid artery: 5 of the animals were anesthetized with sodium barbital and 2 with ether. Recovery of the blood pressure occurred sharply and nearly completely after the first few withdrawals, slowly and less completely after the later bleedings. Erythrocyte counts showed a diminution in all cases. From 19 to 35 per cent of the calculated blood volume was obtainable, the average being 24.9 per cent, after from 33 to 64 per cent of the calculated blood volume had been removed by bleeding (see Table VIII). The average

total amount bled during the experiment and at the terminal bleeding was 70.4 per cent of the calculated blood volume: this increase over the amount obtainable at one continuous bleeding is presumably due to the absorption of fluid from the tissues during the slow bleeding.

9. PLASMAPHERESIS

The reduction of the blood pressure was attempted in several animals by the withdrawal of a quantity of blood after heparin administration, the plasma being removed by centrifugation, and replacement of the cells: these experiments were unsuccessful, the time interval being very long and death frequently occurred in the later stages before the cells could be replaced, as noted by Bayliss. Therefore the following plan was adopted, 2 animals being used: blood from dog 1 was drawn, centrifuged, and its plasma decanted, then dog 2 was bled, and cells from dog 1 immediately replaced in proportionate quantity. This process was repeated two or three times, until the blood pressure remained at a shock level (after from 34 to 52 per cent of the calculated blood volume had been removed as plasma) at which time the animals were bled to death. By this technique the time required was reduced to an average interval of 82 minutes: no reactions attributable to foreign protein were observed. The blood was, of course, concentrated by the procedure. In 5 cases the amounts bled were from 15.5 to 27 per cent of the calculated blood volume, and the average was 19.7 per cent. The average total volume of fluid removed during the experiment and at the terminal bleeding was 50.1 per cent of the calculated blood volume: this figure is lower than the average total volume removed during the hemorrhage experiments and probably indicates that the greater loss of plasma proteins and correspondingly lower osmotic pressure of the blood in the plasmapheresis experiments permitted less withdrawal of the tissue fluids into the blood stream.

10. MANIPULATION OF THE INTESTINES

Experiments on intestinal manipulation in dogs by Phenister and Parsons indicate that the intestinal volume is not increased during the procedure.

TABLE VI—HIGH SPINAL ANESTHESIA

Experiment	Anesthetic	Blood pressure		Time minutes	Terminal bleeding volume per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
310	E	114	60	30	33
311	E	133	38	35	43
313	E	133	43	45	40
317	E	130	61	70	35
323	E	140	15	30	40
417	E	137	70	90	44
Average			61	55	44

and Blalock (3) found that a plasma like exudation occurs from the surface of the intestine in adequate amounts to explain the fall of blood pressure.

In 6 dogs of the present series the intestines were brought out through an abdominal incision and severely massaged with the fingers. 5 were anesthetized with ether, 1 with sodium barbital. There was little or no external hemorrhage although moderate ecchymosis occurred in the area manipulated, and a considerable weeping from the surface of the bowel was observed as described by Blalock. The fall of blood pressure was very gradual and could not be much accelerated by more vigorous massage; hence the time interval was increased to an average of 104 minutes. The bleeding volumes were from 12 to 21 per cent of the calculated blood volume, the average being 18 per cent. The erythrocyte counts were irregularly increased indicating a concentration of the blood in all cases.

II. UPPER ABDOMINAL MANIPULATIONS

The fall of blood pressure which occasionally occurs during operations in the upper abdomen in man, and which is usually accompanied by a slowing of the pulse, is presumably a reflex phenomenon and may be related to the cardio-inhibitory reflex from the upper abdomen of certain species and easily demonstrable in the frog (Luckhardt).

Several unsuccessful attempts were made to reproduce this effect in dogs, by traction upon and resection of the gall bladder and stomach and by stimulation electrically of the gastric vagi below the diaphragm. No satisfactory fall of blood pressure of adequate duration for study could be obtained in the dogs tested.

DISCUSSION OF RESULTS OF EXPERIMENTS

The results of all types of experiments are summarized in Table VI. It will be noted that the average bleeding volume for the normal anesthetized dogs (series 1) was 58.6 per cent of the calculated blood volume, and that the bleeding volumes after reduction of the blood pressure fall into two groups according

TABLE VII—TRAUMA TO AN EXTREMITY

Experiment	Anesthetic	Blood pressure		Time minutes	Terminal bleeding volume per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
407	S-B	114	47	5	24
409	S-B	113	44	60	25
503	S-B	166	60	91	10.5
510	S-B	107	51	55	13
Average			40	63	16

TABLE VIII—HEMORRHAGE

Experiment	Anesthetic	Blood pressure		Time minutes	Amount bled during experiment, per cent of the calculated blood volume	Terminal bleeding volume per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg			
349	E	150	61	65	30	20
371	E	127	35	66	34	10
473	S-B	160	60	70	39	20
474	S-B	131	61	73	61	19.5
475	S-B	147	7	63	33	19
476	S-B	103	61	57	?	23.7
493	S-B	150	47	58	45	33
Average			61	61	45.5	24.0

to whether there is a slight or a marked reduction of the bleeding volume.

The first group includes the following procedures: hyperventilation, anaphylaxis, histamine administration, spinal cord section and spinal anesthesia. In these (series 2b to 6, inclusive), there was obtained from 44 to 56 per cent of the calculated blood volume figures but slightly diminished from the normal, and the two lowest figures of the group were in the conditions of spinal anesthesia and spinal cord section in which a small operation was included in the procedure. The mechanism of the blood pressure depression in these experiments was by arteriolar or capillary dilatation or both, and the maintenance of nearly normal bleeding volumes indicates that the circulating blood volume is not greatly diminished.

In the conditions of trauma to an extremity and hemorrhage (series 7 and 8) there was obtainable at similar blood pressure levels a much smaller volume of blood, approximately 25 per cent of the calculated blood volume, and an even greater reduction of the bleeding

TABLE IX.—PLASMAPHERESIS

Experiment	Anesthetic	Blood pressure		Time, minutes	Plasma removed, per cent of the calculated blood volume	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg			
136	S-B	96	72	85	32	
138	S-B	75	83	95	26	17.6
142	S-B	58	58	97	38	5.5
147	S-B	128	63	77	24	17.5
151	S-B	33	80	64	27	7
Average			67	8	30.4	19.7

TABLE X.—INTESTINAL MANIPULATION

Experiment	Anesthetic	Blood pressure		Time, minutes	Terminal bleeding volume, per cent of the calculated blood volume
		At beginning, mm. Hg	At end, mm. Hg		
11	E	140	30	179	8
133	E	10	30	80	20
134	E	45	45		0
135	E	90	30	12	
136	E	143	45	89	18
4	S-B	79	58	83	
Average			46	104	8

volume occurred after lowering the blood pressure by plasmapheresis, and by manipulation of the intestines (series 9 and 10) approximately 20 per cent of the calculated blood volume being obtained. These 4 series constitute a second group of experiments in which a considerable reduction of the bleeding volume occurred as a result of actual loss of circulating blood volume. The erythrocyte counts made in this group although somewhat irregular indicated a dilution of the blood in extremity trauma and hemorrhage and a concentration of the blood in plasmapheresis and intestinal manipulation; the corresponding differences in viscosity may account for the differences in the bleeding volumes i.e. the more concentrated blood of plasmapheresis and intestinal manipulation may permit a smaller circulating blood volume to maintain a given blood pressure than the diluted blood of trauma and hemorrhage. As has already been noted the blood pressure behaved similarly in its reaction to repeated withdrawals of blood and to repeated traumatizations of an extremity there being little

TABLE XI.—SUMMARY OF ALL TYPES OF EXPERIMENTS

Series	Procedure	Number of cases	Average bleeding volume, per cent of the calculated blood volume
	Normal dogs	20	26.6
16	Hyperventilation	5	26.3
3	Anaphylaxis	5	17.0
4	Histamine administration	6	20.5
5	Spinal cord section	6	48
6	Spinal anesthesia	6	44
7	Trauma to an extremity	4	4.8
8	Hemorrhage	7	24.6
9	Plasmapheresis	5	19.7
10	Intestinal manipulation	6	18

effect at first and an increasing effect later in the procedure. The coincidence of the bleeding volumes of this group of experiments and the other findings support the opinion that the fall of blood pressure in experimental trauma and intestinal manipulation is due to local loss of fluid as blood or blood and plasma into the damaged tissues and as plasma exudation from the intestine.

By comparing the bleeding volumes of the two groups of experiments it is apparent that the animals of the first group were in much better condition by virtue of their nearly normal circulating blood volume, to withstand hemorrhage or an operation than the animals of the second group in which the bleeding volume was markedly reduced during the time period considered in the present studies. Therefore a lowered blood pressure of such duration is not as serious a condition when produced by vasodilatation or "bleeding into the vessels," as some writers have implied as when the pressure is lowered to similar levels by actual loss of fluid from the circulation, as in experimental trauma, intestinal manipulation and hemorrhage.

While these experimental procedures do not exactly simulate surgical shock in man the findings apply to the problem of its mechanism at least in part. Therefore, it is thought that in clinical shock (1) the hidden loss of fluid for instance locally into the tissues in trauma, may be more important as an etiological agent than toxemia or other suggested

factors, (2) the blood pressure is not in itself an adequate guide as to the condition of the patient, as it may be nearly normal in the presence of a seriously embarrassed circulation or vice versa, and (3) further hemorrhage or an operation is more dangerous when the blood pressure is lowered by hemorrhage or by trauma, in which blood or plasma is lost, than by spinal anesthesia or other vasodilator mechanism in which there occurs the so called "bleeding into the vessels." And clinical experience warrants the inclusion in the vasodilator group the depression of the blood pressure which occurs during upper abdominal operations with a concurrent slowing of the pulse. Spinal anesthesia was demonstrated to have but slight influence on the bleeding volume and presumably the circulating blood volume and is therefore to be considered but slightly more dangerous than ether or barbitol anesthesia.

SUMMARY

The state of the circulation in 50 anesthetized dogs after lowering the blood pressures to "shock levels" by 9 different methods was studied by comparing the average bleeding volumes of each series i.e. the average amount of blood obtained by bleeding usually after the lapse of 1 hour. The average bleeding volume of 20 normal anesthetized dogs was 58.6 per cent of the calculated blood volume. The experiments fell into two groups according to whether or not a considerable diminution of the bleeding volume occurred at the reduced pressure.

In the first group of experiments the average bleeding volume was 56.2 per cent of the calculated blood volume when the blood pressure was lowered by hyperventilation 51 per cent when by anaphylaxis, 50.5 per cent when by histamine administration 48 per cent after spinal cord section, and 44 per cent with high spinal anesthesia. The average bleeding volume for the entire first group was 49.9 per cent of the calculated blood volume, a slight depression from the normal average. In the conditions enumerated the mechanism of depression of the blood pressure was by dilatation of the arterioles or capillaries or both. It was concluded that in these conditions, dur-

ing the time interval studied, there was little or no diminution of the circulating blood volume at the reduced pressure, and it would seem that the lowered blood pressure of spinal anesthesia did not appreciably increase the dangers of operation or hemorrhage, since the blood volume remained at or near normal.

In the second group of experiments the average bleeding volume was found to be 24.9 per cent of the calculated blood volume after the blood pressure had been lowered by hemorrhage 24.6 per cent when by trauma to an extremity, 19.7 per cent after plasmapheresis and 18 per cent after intestinal manipulation. The average for the entire group was 21.8 per cent of the calculated blood volume and was thus very considerably reduced from the normal. In the case of hemorrhage and plasmapheresis there was direct and obvious loss of fluid from the blood stream, and a similar loss presumably occurred in the conditions of trauma, where there was local loss of blood and plasma into the injured area and in intestinal manipulation where the fluid appeared to be lost principally as plasma. It was concluded that in this second group of experiments the circulating blood volume was much more seriously diminished at similar blood pressure levels than in the first group, and that the animals were correspondingly less able to withstand hemorrhage or an operative procedure. The similarity of the bleeding volumes was further evidence that the mechanisms of lowering the blood pressure are identical in trauma to an extremity and hemorrhage, and in intestinal manipulation and plasmapheresis.

CONCLUSIONS

1. In states of circulatory depression the blood pressure is an inadequate index of the seriousness of the condition.

2. The circulating blood volume is not seriously diminished, and hence operation or loss of blood is well tolerated, in conditions of lowered blood pressure due to vasodilator mechanisms, such as spinal anesthesia, and including presumably the fall of blood pressure which sometimes occurs in upper abdominal operations in man with a concurrent slowing of the pulse.

3 The circulating blood volume is markedly diminished when the blood pressure is reduced by hemorrhage experimental extremity trauma or experimental intestinal manipulation. In these conditions the animal is much less able to withstand further hemorrhage or an operation than if the blood pressure be depressed to a similar degree by a vasodilator mechanism.

4 The effects of experimental trauma and intestinal manipulation on the blood pressure are due to local loss of fluid rather than to a toxæmia.

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PASSIVE ANTITOXIC IMMUNITY IN STREPTOCOCCAL INFECTION OF THE PERITONEUM

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ALTHOUGH antibacterial sera have been discredited as agents for the prevention and treatment of streptococcal infections in the reports of McLeod, Novak and others, antitoxic sera are at present enjoying considerable popularity. Warnick, Lousos and Becker, Cressler and Lash have prepared antitoxic sera using puerperal strains of streptococci and describe the favorable effect of such sera in severe infections in the puerperium. Furthermore, in accordance with the concept of the unity of the streptococcal toxins, which is supported by the experimental work of Paraf, Eagles, Smith, Parish and Okell, Moriawaki and Wadsworth, antibodies specific for the toxins of scarlet fever streptococci are being applied in the treatment of a variety of other streptococcal diseases.

Schabatai has used scarlatinal antitoxin with success in the treatment of erysipelas. Sanderson, Capon and MacWilliam have found that the administration of scarlatinal antitoxin produces a favorable effect in streptococcal septicaemias. Boente and Killian have described the successful use of scarlatinal antitoxin in the treatment of a number of different diseases having a streptococcal etiology including puerperal fever, acute angina, lung abscess, mastitis and cellulitis. Baird and Cruickshank have reported a reduction in the incidence of puerperal infection by prophylactic administration of scarlatinal antitoxin. Few reports, however, of specific treatment of streptococcal infection of the peritoneum using antitoxic sera are to be found in the literature. Wilkie obtained encouraging results with the therapeutic administration of convalescent serum in streptococcal infections of the peritoneal cavity, and Duncan has suggested that it may be advisable to give scarlatinal antitoxin in the treatment of primary streptococcal peritonitis in children.

The present work was undertaken to determine experimentally the potentialities of

antitoxin in the treatment of a streptococcal infection of the abdominal cavity and to investigate the bodily reactions associated with passive antitoxic immunity in such a disease. The experiments were limited to an investigation of the infective process produced by a Dochez strain of streptococcus isolated originally from a case of scarlet fever. The organism was only moderately virulent but an active producer of toxin. Filtrates of 72 hour tryptic digest broth cultures giving a positive skin test in a susceptible individual in a dilution of 1 to 1000 and killing rabbits of 1800 to 2000 grams weight within 24 hours when injected intravenously in doses of 10 cubic centimeters.¹

EXPERIMENTAL

Prophylactic effect of antitoxin. Ten rabbits that had received subcutaneous injections of 2 cubic centimeters of antitoxin 16 hours previously, with ten normal controls, were given an intraperitoneal injection of 10 cubic centimeters of 16 hour tryptic digest broth culture of the streptococcus. The animals were studied in pairs, one protected by antitoxin and one unprotected and were selected according to breed, sex and weight. Of these rabbits, all of the unprotected died in 6 to 20 hours, all of the protected animals survived and were killed at intervals after recovery from the acute infection. Three of the surviving animals were killed after 1 week, 1 after 2 weeks, 1 after 3 weeks, and 5 were allowed to live for 30 days. In this experiment changes in weight, temperature, peritoneal fluid and blood picture including total white blood cell count, white blood cell differential count, red blood cell count, haemoglobin percentage and blood culture were studied, particular attention being paid to the sequence of events in the blood and peritoneal fluid during the first 6 hours.

¹ The antitoxin used in all experiments was that produced by Burroughs-Welcome Company, and known as concentrated streptococcus antitoxin (scarlatina) globulin.

TABLE I—DIFFERENTIAL COUNTS OF PERITONEAL FLUID LEUCOCYTES

Rabbit 668—Polish male, 1660 grams antitoxin before infection (Numbers=percentages)

	Monocytes	Eosinophils	Lymphocytes	Poly morphs	Macrophages
Start	80		20		
20 mins	40		30	30	
hrs				95	
6 hrs				94	4
hrs				90	5
24 hrs				82	3
1 days	5		4	95	35
Week	8			49	2
30 days	40	4	50		

Rabbit 669—Polish male, 1840 grams Control.

	Monocytes	Eosinophils	Lymphocytes	Poly morphs	Macrophages
Start	8		7		
20 mins	54		30		
hrs		3	5	80	
hrs			6	84	

Animal dead in twenty hours

As a control upon the specificity of the protection conferred by the streptococcus anti toxin rabbits that had received prophylactic injections of concentrated diphtheria anti toxin-globulins¹ were inoculated intraperitoneally with the standard dose of streptococcus culture. These animals succumbed to the infection in the same time as the normal controls.

After the injection of culture the unprotected animals gave symptoms of a greater toxæmia than the passively immunized group and were usually prostrated by a diarrhoea during their short period of resistance to the infection. All of the animals receiving anti toxin showed an increase in temperature within 6 hours, to a level above 104 degrees F. In the unprotected controls on the other hand an inhibition of the temperature reaction was noted 8 of these animals showing a temperature below 100 degrees F. 6 hours after the injection of culture. Examinations of the leucocytes of the peritoneal fluid in film preparations demonstrated that the mobilization

Burroughs-Wallace product

TABLE II—BLOOD LEUCOCYTES IN INFECTIONS—POLYMORPHONUCLEAR AND LYMPHOCYTE COUNTS (PER CUBIC MILLIMETER OF BLOOD)

Rabbit 665—Chinchilla male, 1930 grams antitoxin before infection

	Total WBC	Polymorphonuclears		Lymphocytes	
		Per cent	Absolute count	Per cent	Absolute count
Start	6,800	23	1,568	44	2,992
20 mins	1,300	54	702	30	390
hrs	1,600	69	1,104	3	500
6 hrs	1,100	8	88	5	55
24 hrs	7,200	84	6,048	26	1,872
48 hrs	300	53	159	8	240
72 hrs	16,000	36	5,760	37	5,920
96 hrs	21,400	6	1,284	16	4,624
Week	7,400	43	3,182	34	2,516
30 days	4,800	23	1,104	35	1,680

Rabbit 664—Chinchilla male, 1850 grams Control.

	Total WBC	Polymorphonuclears		Lymphocytes	
		Per cent	Absolute count	Per cent	Absolute count
Start	8,200	24	1,968	53	4,356
20 mins	5,700	5	285	38	2,166
hrs	300	23	69	28	84
6 hrs	1,000	30	300	15	150

Dead after 20 hrs

of polymorphonuclear leucocytes in the abdominal cavity during the acute phase of the infection was more pronounced in the immunized animals than in the control group and phagocytosis of the infecting organisms was more effective in the animals receiving anti toxin. In the protected animals the phase of recovery from the infection was characterized by a diminution in the numbers of the polymorphonuclear cells in the peritoneal fluid with a restoration of the normal predominance of the mononuclear leucocytes (Table I).

In the blood, an early leucocytosis, followed by a marked leucopenia, was characteristic of the reaction to the inoculation with streptococcal culture in both the immunized animals and the controls. The animals receiving anti toxin showed however a greater leucocytosis in the first 20 minutes and the succeeding leucopenia was less pronounced in this group.

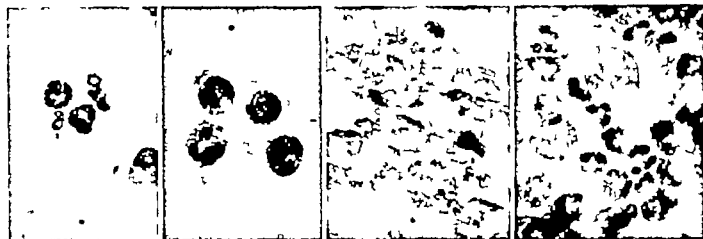


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1. Photomicrograph of peritoneal exudate from a normal animal 7 hours after injection of culture. Polymorphonuclear leucocytes have degenerated appearance. Phagocytosis is failing; free streptococci marked \times 580.

Fig. 2. Peritoneal exudate from immunized animal 7 hours after injection of culture. Effective phagocytosis is shown; leucocytes contain cocci. \times 580.

Fig. 3. Photomicrograph of omentum of unprotected animal 7 hours after inoculation. Failure of phagocytosis demonstrated. Free streptococci, \times 580.

Fig. 4. Photomicrograph of omentum of protected animal 7 hours after inoculation. There is a marked polymorphonuclear reaction, and streptococci are within phagocytes. \times 580.

The averages of the white blood cell counts per cubic millimeter of blood after 20 minutes and 6 hours in the two groups of animals were as follows: 20 minutes—immunized animals 23,135 controls 15,665; 6 hours—immunized animals 6,090 controls 4,922. The leucopenia was continued until death in the group of unprotected rabbits. In the protected group, however, a second and more prolonged leucocytosis was commonly observed after 48 hours.

Differential and absolute counts of the white blood cells showed that the polymorphonuclear leucocytes were of the chief importance in the leucocytic reaction to the acute infection (Table II). Depression of the polymorphonuclear response was noted in the group of unprotected animals.

Blood cultures indicated that a more severe bacteraemia occurred in the unprotected rabbits. Six hours after infection all of these animals gave a positive blood culture, while only one test was positive in the protected group after the same interval.

A moderate anemia and a decrease in weight were characteristic of the first week following infection in the animals protected by antitoxin. After 30 days the hemoglobin percentage and red blood cell count had returned to their normal values in most animals,

and compensation had usually been made for the initial weight loss. Two of the rabbits protected by antitoxin developed within the first week an arthritis affecting the joints of the hind legs. These inflammations persisted until the animals were killed after 2 and 3 weeks, respectively.

Postmortem, the normal controls showed the histological changes characteristic of an acutely fatal infection. The peritoneal fluid and the membranes of the abdominal cavity showed a failure of the leucocytic reaction with proliferation of the streptococci, and cultures of the heart blood and peritoneal fluid were uniformly positive for the organism. In the anterior mediastinal lymph nodes, numerous streptococci were observed in the lymph sinuses. Organisms were also readily demonstrated in sections of the liver and spleen of animals dying later than 10 hours after injection with culture. Foci of necrosis were observed in the liver. Acute congestion of the lungs, spleen and kidneys was noted, and hemorrhages were found in the heart muscle. Evidences of a severe drain upon the leucoblastic tissues were observed in sections of the bone marrow, with degenerative changes in the hematopoietic cells. The picture presented in this group of animals was that of a toxic depression of the vital systems of the



Fig. 5

Fig. 5 Diaphragmatic lymphatic of unprotected animal 7 hours after inoculation. Streptococci. $\times 200$



Fig. 6

Fig. 6 Photomicrograph of peripheral lymph sinus of anterior mediastinal lymph node in unprotected animal 7 hours after inoculation. Dark masses are aggregations of streptococci. $\times 200$

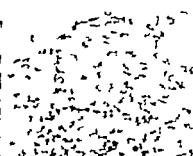


Fig. 7

Fig. 7 Photomicrograph of peripheral lymph sinus of anterior mediastinal lymph node in immunized animal 7 hours after inoculation. There is a marked concentration of polymorphonuclear leucocytes; no bacteria are to be seen. $\times 200$

body, especially that concerned with leucocytic reaction to pathogenic bacteria, allowing a generalized invasion of the body from the original focus of infection in the abdomen.

In the protected animals killed after their survival of the acute phase of the infection, a marked hyperplasia of the lymphoid tissues throughout the body was observed with a pronounced myeloblastic reaction in the bone marrow. A marked development of myeloid tissue was also noted in the spleen in animals killed 1 week after infection. In addition to the 2 cases of arthritis already noted, a sub-acute pericarditis was found in one animal at autopsy. In the group of immunized animals, recovery from the infection of the abdominal cavity was apparently correlated with an intense reaction of the leucoblastic tissues of the body. The residual chronic foci of infection found in these animals, in spite of the prophylactic administration of antitoxin, undoubtedly had their origin in a blood stream infection associated with the acute peritonitis.

Comparison of immunized animals with normal controls in same phase of acute infection. In order to compare the histological changes in the protected and unprotected animals during the same phase of the acute infection, 4 rabbits receiving prophylactic injections of streptococcus antitoxin with 4 normal controls, were killed 7 hours after having been inoculated intraperitoneally with 10 cubic centimeters of standard culture and complete autopsies were performed.

Total counts of the cells of the peritoneal exudates in these animals post mortem demonstrated that the leucocytic response in the immunized rabbits was quantitatively greater than that in the controls. A greater quantity of exudate was present in the abdominal cavity of the immunized animals, and when total counts were made of the peritoneal leucocytes, the average number of cells in the protected group was found to be 8,500 per cubic millimeter of fluid, as compared with an average count of 625 per cubic millimeter in the controls. The predominance of polymorphonuclear cells among the leucocytes of the peritoneal fluid was also more pronounced in the protected rabbits than in the controls. The average of the polymorphonuclear percentages in the immunized rabbits was 96, as compared with a corresponding average of 67 in the control group.

A greater mobilization of leucocytes in the tissues of the omentum with more marked phagocytosis of the infecting organisms, was noted in the immunized animals and preparations of the diaphragmatic lymphatics and anterior mediastinal lymph nodes also gave evidence of a more effective leucocytic reaction to the bacterial invasion in this group. Centers of proliferation of the streptococci were seen in the omentum, diaphragmatic lymphatics, and anterior mediastinal lymph nodes in the normal controls.

Therapeutic effect of antitoxin. Six rabbits were given an intravenous injection of 2.5



Fig. 8

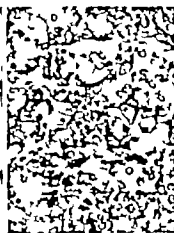


Fig. 9



Fig. 10



Fig. 11

Fig. 8. Photomicrograph of liver of unprotected animal dying 20 hours after inoculation. Dark mass is aggregation of bacteria. $\times 525$.

Fig. 9. Photomicrograph of liver of unprotected animal dying 20 hours after inoculation. Marked necrotic changes in liver cells. $\times 525$.

Fig. 10. Photomicrograph of bone marrow of unprotected

animal dying 20 hours after inoculation. Nuclear degeneration in myelocytes is shown. $\times 525$.

Fig. 11. Photomicrograph of bone marrow of immunized animal 1 week after inoculation. Marked hyperplasia of leukoblastic tissues. Myelocyte is predominant cell although many mature polymorphonuclear leucocytes are present. $\times 525$.

cubic centimeters of concentrated streptococcus antitoxin 3 hours after having received 10 cubic centimeters of culture intraperitoneally. The time interval between the inoculation with culture and the injection with immune serum was of sufficient length to make the test one of considerable severity. A significant prolongation of life resulted however in all instances but one following the administration of the specific antiserum.

As compared with an acutely fatal infection of 10 hours duration in 3 control rabbits receiving therapeutic injections of diphtheria antitoxin the disease in the animals given specific therapy was chronic in nature. The rapid course of the infection was unaffected in one animal which was given streptococcus antitoxin 3 others died after 80 to 128 hours 2 of this group made a complete recovery. In the overwhelming infection of these experiments therapeutic injection of streptococcus antitoxin was commonly followed by an increase in temperature increased phagocytosis of the streptococci by the leucocytes of the peritoneal exudate and a rise in the blood leucocyte count. The pathological changes noted at autopsy in animals dying after several days of resistance to the infection were those of a severe septicemia.

Control experiments. The changes in temperature blood picture and peritoneal fluid

observed in experiments in which intraperitoneal injections were made of simple digest broth and of the filtrate of a 16 hour streptococcal culture showed that the inoculum of the reported experiments contained toxic substances apart from the bacteria themselves. The toxicity of these substances was not great however and the irritating properties of the products of bacterial metabolism present in cultures after 16 hours of incubation may be considered to constitute a constant factor in the experimental infections.

SUMMARY AND CONCLUSIONS

1. In the present work it has been found that a high degree of immunity to intraperitoneal inoculation with a toxigenic moderately virulent scarlatinal streptococcus can be produced by the administration of specific antitoxin. From the experimental evidence this immunity seems to depend upon the neutralization by the antibody of toxin produced by the infecting organism *in vivo* and the resistance of the body to the infection which is facilitated by the elimination of the toxic factor is manifested by an increase in temperature a local and general mobilization of leucocytes and the removal of the invading bacteria from the peritoneal cavity and blood stream by phagocytic cells. The immunity conferred by the prophylactic administration

of antitoxin enables the animal body to survive the acute phase of a disease which is rapidly fatal for the unprotected control but even this high degree of antitoxic immunity is not sufficient to prevent the development in a certain percentage of cases of later chronic infections. Therapeutic use of antitoxin has definite limitations as indicated by the experimental results. The administration of the antitoxin after the onset of the infection appears to enhance the defensive powers of the body however and may be followed by a completely successful resistance to the bacterial invasion and recovery.

2 The findings in these experiments substantiate the view of Downie, that toxin aids the establishment of streptococcal infection by inhibiting phagocytosis. As neutralizing toxin and favoring the leucocytic reaction to the bacterial invasion antitoxin appears to possess distinct potentialities for the control of infections of the abdominal cavity caused by toxigenic streptococci.

3 The present work indicates that the highest degree of passive antitoxic immunity in streptococcal infection of the peritoneum is produced by prophylactic administration of the serum. In the therapeutic use of antitoxin it would seem, however that the administration of the serum very early in the disease might confer a protection comparable to that produced by prophylactic infection. Early therapeutic administration of antitoxin should restrict tissue invasion to a minimum, and

thereby limit the possibility of infections of a focal nature developing as complications.

This report represents a summary of experiments performed by the writer as a Rhodes Scholar elected from the Washington University School of Medicine (1930-1932). The writer is greatly indebted to Professor George Dreyer, F.R.S., for his advice and material support in carrying out these experiments. He also wishes to express here his gratitude for very stimulating criticisms and suggestions that have been received from Dr. A. W. Downie of the University of Manchester, Professor J. W. McLeod of the University of Leeds, Dr. G. H. Eagles of the Lister Institute, Professor D. F. Cappel of the University of St. Andrews, Professor D. P. D. White of the University of Edinburgh, and Dr. T. B. Heaton, Dr. R. L. Volkmann, and Dr. H. M. Carleton of the University of Oxford.

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THE TREATMENT OF LATE ACUTE INTESTINAL OBSTRUCTION

RECENT EXPERIMENTAL AND CLINICAL STUDIES¹

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IN this discussion of acute intestinal obstruction I shall be concerned almost entirely with the late and therefore serious cases which of course offer the greatest problem in treatment. The patient seen early generally does very well and such cases carry a low mortality, even after a radical operation for relief. It is obvious therefore that the education of the public as well as the profession in early diagnosis would reduce the tremendously high mortality. Moreover if the use of purgatives for abdominal pain were generally avoided I am sure the treatment would also be easier and more favorable. Unfortunately we cannot wait until such education becomes effective. The mortality (15) of intestinal obstruction is still around 60 per cent, as high as it ever was in spite of the great amount of research on the subject. In 1926 in the mortality statistics of this country over 10,000 deaths were recorded from intestinal obstruction. We are confronted constantly with patients in the later stages of this disease. It is the consideration of such patients to which I wish to direct attention.

A woman, for example, some weeks or months after a simple hysterectomy suddenly develops abdominal cramps which go away as quickly as they come only to return in a few minutes or after an hour or two. The patient thinks it is an ordinary belly ache and takes a dose of salts has a moderate bowel movement, but the pain continues and she notices that her abdomen is becoming more distended. She then takes some castor oil but the pain becomes worse and she vomits. The distention becomes more marked and the pain perhaps diminishes in severity. The vomitus may become foul in odor. A doctor is called, she is rushed to the hospital, operated upon and dies or she may not call a doctor and die without benefit of a diagnosis.

What was the cause of death? We are accustomed to explain the symptoms of prostration and weakness which develop before death as due to a toxæmia. In spite of the fact that we have no absolute evidence that this is

in fact true. During the past few years a series of new observations have been made as to the cause of death which have contributed greatly to our understanding and treatment of certain of these cases. Some of this work has been done in the Surgical Laboratory at the Washington University Medical School and in Barnes and other hospitals associated with it. In order to present these observations more clearly it will be of advantage for purposes of discussion to divide intestinal obstruction into two groups: (1) High obstruction that is at the pylorus from a scarred duodenal ulcer or hypertrophic stenosis or carcinoma or at the terminal duodenum from adhesions some times developing after gastro-enterostomy, congenital bands, etc. (2) Low obstruction which is by far the most frequent and is located commonly at the ileocaecal valve or beyond, due to adhesions following operation especially after a ruptured appendix, a congenital band, strangulated hernia, carcinoma, etc. The pathology of each will be first discussed and treatment will be taken up later. Strangulation will be considered separately later on. Intestinal obstruction complicated by peritoneal infection as well as the so called paralytic ileus will not be included in the scope of the paper.

HIGH OBSTRUCTION

Persistent vomiting is a prominent symptom of high obstruction and comes on almost immediately after ingestion of food or liquid. The vomitus contains not only the fluid swallowed but gastric and pancreatic juice as well. These secretions often pour out in absence of any food intake and sometimes several liters may accumulate in a dilated stomach with very little actual vomiting. Distention is usually limited to the upper abdomen. Increasing weakness and prostration rapidly develop with the absence usually of much pain. The pulse grows weaker and faster the skin becomes

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drawn and dry, the sensorium depressed and coma and death supervene in a few days, if the patient is untreated and if the obstruction is complete. Because these changes occur more quickly and death more rapidly than is the case in low obstruction it was for a long time assumed that the toxæmia was more severe the higher the occlusion.

We now know that in high obstruction the factor of toxæmia is of little or no significance. It may be of some interest to trace briefly the development of this advance. Hartwell and Hoguet of New York in 1913 were the first to escape from the toxæmia theory by adducing evidence that death resulted from loss of water by vomiting. They made no studies of the blood. Haden and Orr in 1923 reported low blood chlorides but for a long time still clung to the idea of a toxin which combined with the chloride ion. They later gave up this idea. Our work began in 1926 when with Dr. McCaughan I first reported that total loss of pancreatic juice was rapidly fatal (7). The symptoms were not unlike those seen after high intestinal obstruction. There was vomiting, weakness, fast pulse, prostration, shock and death usually within 7 days. We were unable to explain this rapid death until with Dr. Hartmann intensive studies of the blood chemistry were made (5). We found briefly that the experimental animals with pancreatic fistula showed the same changes as babies with severe diarrhæa, patients with duodenal or pancreatic fistula or high intestinal obstruction. These changes were those of anhydramia, i. e. a high protein content often up to 11 per cent from a normal of 7 per cent, a low water content indicating marked concentration of blood as shown also by a high hematocrit reading, a loss of base and chlorides, acidosis and finally a rise of non protein nitrogen. These changes can be explained on a purely chemical basis from the loss of water and salts in the drained pancreatic juice or in the vomitus in high obstruction. In other words, constant vomiting removes from the body not only water but the important salts of the gastric and pancreatic secretions which are normally reabsorbed to some extent from the intestine. The high non protein nitrogen is probably due to

the anuria since the blood becomes too thick to pass the kidney capillaries.

Practical proof of the idea that we were dealing with purely chemical and physical changes was shown by the striking improvement in symptoms upon replacing the lost water and salts by means of intravenous injections of Ringer's solution which contains the common salts that are found in the gastric and pancreatic secretions. Animals moribund from loss of pancreatic juice could be brought back to life by the introduction of sufficient combined solution, a modified Ringer's solution which I will describe later. In subsequent experiments (6) with high intestinal obstruction and fistula we were also able to cure the so called toxic symptoms and prolong life by replacing the essential water and salts, lost in the vomitus, by parenteral injections.

These observations, with which most of you are by now undoubtedly familiar are of course not characteristic of high obstruction. They are really due to loss of gastro-intestinal secretions from the inevitable concomitant vomiting. They apply equally to the profuse vomiting in infants from pyelitis, or other infections in protracted hysterical vomiting where no gastro-intestinal lesion is present in severe diarrhæa where the secretions pass through so quickly that no fluid is reabsorbed and in high intestinal fistula. Indeed if one minimizes vomiting in a high intestinal obstruction by withholding all fluid by mouth symptoms are delayed and life is likewise prolonged.

Thus one can see that practically everything we know about the so called toxæmia of high intestinal obstruction can now be explained on purely physicochemical grounds. The loss of water and salts, in absence of absorption drains the blood of water, base, chlorides, bicarbonate etc. it becomes too concentrated for the peripheral circulation, local outlying acidosis (17) undoubtedly occurs, kidney function stops and death results. Replacing the lost water and salts dilutes the blood back to normal peripheral circulation is re-established, kidney function begins, and the interchange between blood and tissues returns to normal.

LOW OBSTRUCTION

It was hoped for a time that this fruitful development of research in high obstruction could be used in cases of low obstruction. These hopes were only partially realized. We have seen that the key to our understanding of the pathology of high obstruction was the loss of gastro intestinal secretions. In contrast to this very slight loss usually occurs in low obstruction since vomiting is not apt to be a very prominent symptom. Indeed Dr Hartmann and I have investigated the blood chemistry in ileocaecal as compared with duodenal obstructions in some detail (6). The blood changes in low occlusion were relatively slight and certainly not sufficient to explain death. This was true of both patients and experimental animals. Moreover the administration of parenteral solutions influenced the symptoms but slightly and did not delay the inevitable lethal outcome.

There are other important differences. In high obstruction the course of the patient is progressively downward and can be correlated with the increasing dehydration of the blood. In low obstruction the so called "toxic" symptoms may not appear for days even in the presence of distention which may be severe. Pain may also have diminished. The pulse rate may be normal and the blood pressure unchanged. Yet not infrequently sudden shock and death occur often within a few hours. At autopsy there is no perforation or other obvious cause for death. We have seen this phenomenon occur similarly in experiments on dogs. Pediatricians see it in infants with so called intestinal intoxication.

I have several times noted that suddenly dilating an enormously dilated bowel above a long standing obstruction may lead to a rapidly fatal outcome. This has also been the experience of others. Heusser and Schar cite the case of a 3 year old child who 4 months after operation for a ruptured appendix and while apparently well suddenly developed acute obstruction. At operation a single band was found occluding the distal ileum which was cut and the obstructed contents seen to pass into the healthy bowel but 10 hours later the child was dead. The authors produced closed loops in rabbits. The distended

bowel was opened in 24 hours whereupon the animals died within 10 minutes. We have seen the same phenomenon occur several times. The sudden access of obstructed fluid into normal bowel has been assumed to be the cause of sudden death but we have no evidence that any of the toxic material present in the fluid is absorbed from the normal intestinal mucosa. More likely it seems to me, is the sudden release of tension in the distended bowel.

The key therefore to the pathology of low obstruction in my opinion is first the inevitable distention which it produces, second the effect of sudden release of tension. These two facts I shall consider in some detail.

Distention. Distention is an early and important symptom and sign and is due to the attempts on the part of the body to overcome the occlusion. Wave after wave of peristalsis, associated with the characteristic cramping pain tries to break through the occlusion and succeeds only in dilating the intestine more and more to make room for the intestinal contents brought down and which cannot get through. The stagnation leads to increased bacterial action and the resulting gas produces an added force distending the gut still more. This leads to a vicious circle, for the increased pressure, at least up to a certain point stimulates the secretory activity of the mucosa (16). Mucus as well as digestive fluids therefore are added to the volume of intestinal contents dammed back from the impassable lumen and the wall stretches still more. Let us examine such an obstructed distended bowel. The contents are partly gas but mostly liquid, foul smelling and very toxic, that is if injected intravenously into an experimental animal. This single fact has dominated much of the research on intestinal obstruction and in my opinion, has belated the true state of affairs. We now know that normal intestinal contents are toxic. They contain active trypsin, peptones, phenols, amines and other substances besides gas bacilli and other bacteria which will kill on intravenous injection. To be sure the obstructed contents contain a much higher concentration of these toxic materials and bacteria. But one can introduce a liter of such fluid into the normal gastro-intestinal tract

and nothing serious occurs. On the other hand there is enough poison and bacteria in a few cubic centimeters of some normal intestinal contents to kill when injected into the circulation. So we see that it is not so much a question of demonstrating a poison in the mucosa, the wall, or the contents of the intestine, but rather of demonstrating whether it gets out, how it gets out and, of course, if it does, what its chemical or bacterial nature is. Attempts have been made it is true to demonstrate the absorption of a toxin. Sugito and Scholefield are the only workers who were able to kill mice with portal blood from obstructed dogs. But their results were not constant and were obtained with difficulty. We have had the same experience. Dr. Cole and I (1) have studied the thoracic duct lymph, portal blood and systemic blood from dogs sick of low intestinal obstruction by injecting the material into guinea pigs which are rather susceptible to toxic amines. We have not convinced ourselves as yet that toxin enters the circulation in abnormal amounts in low obstruction though our studies are still in progress. We have also investigated the liver histologically and functionally (2) in obstructed dogs and although we have found definite and often marked impairment of liver function and histopathological changes we do not believe that they are sufficient to have accounted for death or to support the idea of a toxemia. Recently Dodd, Minot and Casparis found guanidine, a very toxic substance, present in the blood of infants suffering from intestinal intoxication, a disease which many believe is related to obstruction. Dr. Senn and I have followed this idea and have in fact found a high blood guanidine in a few patients and in some dogs with low intestinal obstruction. Our observations are too few to permit general conclusions, but we have some evidence that amines other than guanidine may be present.

Sudden release of distention. It is not surprising as a matter of fact that it is so difficult to demonstrate a toxin outside the lumen of an obstructed intestine. We know from many experimental and clinical observations that distention of the bowel causes an obstruction of venous as well as lymphatic return. This distention is sometimes very

great great enough to cause gangrene especially of the wall opposite the mesentery where the circulation is the poorest. If this is true distention obviously diminishes absorption. The most recent experimental work has shown that absorption above an obstruction is in fact very slight (12). But consider what occurs when such a distention is suddenly relieved. Circulation through the collapsed bowel is immediately altered. Absorption may be accelerated for one thing by the improvement in blood flow. Then too a large area of paralyzed capillaries may be opened for engorgement from the general circulation, thus leaving the systemic circulation poorer in blood and fluids. Such a possibility has been suggested by certain experiments that Dr. Cole and I have just made on the cause of death following acute occlusion of the portal vein (4) which as is well known is a rapidly fatal procedure. We have found that there is an astonishing accumulation of blood trapped in the splanchnic area following portal ligation which is sufficient to account for the symptoms of shock and probably death from loss of blood and fluid alone. That is enough blood is lost from the systemic circulation into the intestinal capillaries to lower blood pressure below that compatible with life. What application if any this has to the problem of low obstruction cannot be said. We do know that the distention which occurs within the lumen of the intestines does actually produce a diminution or even a stoppage in portal out flow sufficient sometimes to produce a gangrene of the bowel. Whether there is a sufficient escape of blood and fluid into the obstructed intestine to lower blood pressure and cause death we do not know. Further investigations, we hope will give the answer. This is of course, all purely speculative but the practical point is that something occurs when the distended bowel suddenly collapses which I believe is deleterious to the patient and may cause sudden death.

SLOW DECOMPRESSION OF DISTENDED BOWEL

Regardless of the mechanism of sudden death I have attempted during the past year to avoid sudden release of distention by gradually decompressing the dilated bowel.

A mushroom catheter is placed into an obstructed loop and brought out through a separate stab wound so that the bowel lies in its natural position. The tube is clamped and released at frequent intervals so that drainage occurs progressively but slowly. Although the number of cases is still small the results were so striking I am tempted to report this procedure. It differs from the usual tube enterostomy which so often really fails to drain. It implies the minimum of operative trauma inasmuch as no attempt is made to cure the obstruction unless of course a strangulation is present in which case the mass is exteriorized for later resection. It emphasizes finally the conservation of the distention as a protective measure for several hours until it is gradually and harmlessly relieved. Dr Wangenstein of Minneapolis, on a recent visit told me he has been treating his cases by passing a duodenal tube and draining the obstructed contents from above, and in 12 cases has seen remarkable improvement in toxic symptoms during the course of several hours. I believe his results are due to the slow gradual decompression of the distended bowel. Further observations of course are needed before one can prove such an assumption. I wish to report one very striking instance from my own cases.

A young negro was admitted to the St. Louis City Hospital with a history of several days' cramping pain and vomiting. A diagnosis of intestinal obstruction was made and operation advised but refused. He left the hospital but returned in 24 hours much more sick and with fecal vomiting, dry skin, fast pulse and more abdominal distention. Several liters of parenteral fluid were given and he was operated on under spinal anesthesia with intravenous sodium chloride to maintain blood pressure for his general condition was very poor. Both obstructed and collapsed bowel was seen after the abdomen was opened but little attempt was made to locate the obstruction aside from satisfying myself that there was no strangulation. The obstructed gut was tremendously distended, bluish in color and on mere contact the serosa and muscularis stripped off. A loop lying in the upper left quadrant was carefully mobilized and a Pezzar (mushroom) catheter was introduced and brought out through a separate stab wound. Every 30 minutes 100 cubic centimeters of fluid was allowed to escape from the tube by releasing the clamp. During this time parenteral fluids were continuously given. I considered the prognosis poor for this was the type of case which does poorly and usually dies within a few hours or a day after operation. I was astonished

therefore to see a bright and cheerful patient the next morning with a flat abdomen, normal pulse and temperature. Several liters drained from the tube during the first 24 hours. He passed gas the following day and went on to a complete recovery. Two weeks later just before we were planning on X-ray studies of his gastro-intestinal tract he developed cramps and vomiting and was operated on soon after. The obstruction was found to be a band crossing the mid ileum which was probably a remnant of the omphalo-mesenteric duct. It was cut. No further abnormalities were found. The wound was closed and the patient has been well since.

THE USE OF HYPERTONIC SALINE

I should like to mention briefly the use of hypertonic salt solution in intestinal obstruction originally advised in order to furnish an abundance of chloride ions to neutralize the supposed toxin. Its physiological effect is now known to be quite different. It is a powerful stimulant of intestinal peristalsis (14) and is an efficient way of promoting evacuation of a paralyzed distended bowel which after enterostomy will not drain sufficiently. Without an outlet for the obstructed contents its use of course, aggravates the distention quite as much as the use of purgatives.

THE USE OF HARTMANN'S SOLUTION

In the administration of parenteral fluids we have found of great value the modified Ringer's solution as made up by Dr Hartmann (9), of the Washington University School of Medicine. It is a physiological buffered solution containing in addition to calcium, potassium and sodium chloride sodium lactate. This lactate itself a calorogenic substance, on being oxidized yields bicarbonate which, slowly formed, directly combats any acidosis present and yet in the presence of alkalosis has no deleterious effect. The solution is made up in a concentrated form in ampuls and we add it either to distilled water or 5 per cent glucose and thus in one solution we have water, salts, buffer, and sugar. When mixed with the proper amount of distilled water it may be given subcutaneously or intravenously in the same manner as physiological saline solution. When made up in 5 per cent glucose the intravenous route is the best. Its effect is really remarkable in

high obstruction or indeed in any case where marked dehydration from vomiting, fistula or diarrhea is the important condition. Patients may be kept alive and with normal pulse and temperature for weeks by giving several liters of combined solution per day. In uncomplicated low obstruction it is beneficial in so far as dehydration is present but of course is not specific or in general does not influence the progress of the disease without other means. The use of this combined solution while familiar to most pediatricians has been found by the surgical staff of Barnes Hospital to be a valuable addition to the surgical armamentarium because it seems to be more effective than ordinary saline and glucose. And here I might mention another point about the use of glucose alone. Glucose with out saline dilutes the blood temporarily stimulates renal excretion of salts, which finally leaves the blood much poorer than it was in both water and electrolytes. It therefore does decidedly more harm than good. Its use in conjunction with a solution containing salts, however promotes diuresis and furnishes a source of needed calories.

CONSERVATIVE TREATMENT

All patients with intestinal obstruction receive several liters of combined solution at once. Gastric lavage is carried out. There is no objection in most cases to the use of a simple low enema to assist in ascertaining whether an obstruction is actually present. (The use of morphia occasionally relaxes a patient sufficiently to allow the obstruction to subside.) I believe one should not in general delay operation more than a few hours in the expectation of any spontaneous release of the obstruction. This of course does sometimes occur.

I remember the case of a young man whose ileum was perforated in several places by a bullet. The holes were all sutured. His postoperative course was smooth for 10 days when he developed acute obstruction for which it was found necessary to operate and a fibrous adhesion was found which was cut. He did well for 10 days and developed a second obstruction which was similarly treated and relieved. He balked, however at operation when the third obstruction occurred for which he was being treated unsuccessfully by the usual conservative means. He left our care for another hospital. A few days later

our resident called the other doctor who told him that the jolting he got in the ambulance coming out must have been pretty severe, for on arrival he asked for a bed pan and had a voluminous evacuation. He has remained well since.

We cannot hope for such miracles more than rarely however and the danger of increasing distention and with it the possibility of strangulation and gangrene from delay is too great to justify much procrastination. Operation should therefore be done within a few hours unless obvious improvement is in progress.

COMPLETE EVACUATION OF THE OBSTRUCTED BOWEL

Since some surgeons have recommended complete emptying of the obstructed bowel to get rid of the toxic contents I should like to mention my experience with such an operation. The procedure is based on the idea that by removing the foul smelling poisonous fluid the toxemia is averted. I have discussed already the toxemia theory upon which this is based and the lack of proof that we are in fact dealing with a toxemia. It is, moreover impossible to remove all the toxic contents. Enough remains to kill several patients if absorbed. It is the absorption that is important and after doing the evacuation operation in several patients, I felt sure that absorption if it occurs, was accelerated by the procedure. This is logical enough from the considerations already mentioned on the effect of the sudden release of distention. This is contrary to the report of Holden who records a mortality of under 6 per cent in 155 cases of acute obstruction basing his low figure on the fact that he eviscerates the patient and systematically strips the bowel from the ligament of Treitz, emptying all contents down to the point of obstruction. This conclusion in my opinion is unjustified until we know the duration of the obstruction in his cases. Early cases do well no matter what we do and his cases may have been for the most part early ones. In late cases too often a fatal outcome ensues no matter what is or is not done. It is moreover physically impossible to do much stripping in the really late cases for any handling leads to tearing of the serosa and muscularis.

THE TREATMENT OF STRANGULATION

If a strangulated, and especially gangrenous bowel is present the origin of symptoms is easy to explain and the extensorization of the non viable gut is obviously indicated. To resect immediately and to make an anastomosis carries a high mortality unless the duration of the disease is short—say 12 to 18 hours. Otherwise we have the dilated bowel above to consider, that is to say the combination of strangulation and obstruction. To resect and anastomose of course, removes the involved bowel and relieves the obstruction at the same time, but though the operation may be easily and quickly performed these patients as already mentioned, too often die shortly after the operation from what I believe is a sudden release of distention. In the late cases there fore, where the mortality is high the non viable bowel is simply extensorized for later resection and plastic repair and the obstructed bowel above decompressed gradually by fractional drainage of its contents.

SUMMARY

The cause of death in untreated complete high obstruction (stomach and duodenum) is probably a physicochemical one due to a depletion of water and salts from the blood into the vomitus or obstructed contents. The resulting dehydration can explain all of the so called "toxic" symptoms. Treatment with a modified Ringer's solution effectively restores the blood to normal, improves symptoms, and permits adequate surgical treatment without great risk.

The cause of death in low intestinal obstruction (ileum and colon) is probably differ

ent, but as yet there is little convincing evidence that a "toxemia" is present. Distention plays a prominent rôle and the idea is expressed that sudden release of distention may be an important factor in the fatal outcome. The operative treatment has therefore been confined in the late cases to gradual decompression of the distended intestine, strangulated bowel being merely extensorized for later removal.

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SURGICAL APPLICATIONS OF THE SCHILLING DIFFERENTIAL BLOOD COUNT¹

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THE newer methods of classifying white blood cells in a differential count provide the surgeon with information of both diagnostic and prognostic import. The differential count in common usage was described by Ehrlich in 1891. This classification has proved its usefulness in detecting gross abnormalities of the blood picture but time after time has failed to show significant changes even in the presence of severe infection. The inadequacies of the Ehrlich differential count have led to the development of classifications that propose to group the cells according to their age. Successful results have been obtained particularly with the polymorphonuclear neutrophils. Arneth's classification (3) first presented in 1904 listed over 80 cell types and consequently proved too complex for practical application in clinical problems. Schilling (19) in 1911 modified Arneth's original conceptions sufficiently to adapt such a scheme to laboratory routine.

Schilling describes only two types of cells in addition to Ehrlich's familiar groups but by doing so finds the advantage of listing granulocytes (polymorphonuclear neutrophils) according to their relative maturity. The two additional cells are the "juvenile" (*jugendliche*) and the band form (*stabkernige* or *stab*). The familiar polymorphonuclear neutrophil with its multilobular nucleus is designated a segment. The classification of granulocytes in order of increasing maturity thereby becomes myelocytes, juveniles, bands, and segments.

Sufficiently accurate differential counts may be obtained by classifying 100 cells. With the blood smear prepared by the Wright stain² the cell types are recognized by Schilling as follows:

1. *Myelocyte* The largest cell of the granulocytic series is spherical in outline with blue

cytoplasm, usually containing fine granules. The nucleus is spherical and relatively large with fine chromatin network and several nucleoli.

2. *Juvenile* This is a large cell differing from the myelocyte in that its cytoplasm is a paler blue with slightly coarser granules. The nucleus is bean- or U-shaped usually containing one or two circumscribed nucleolar condensations. The nuclear chromatin is slightly more condensed than in the myelocyte. This cell is almost identical with Pappenheim's description of the metamyelocyte.

3. *Band* The cell is recognized by its rod or band-shaped nucleus containing condensed chromatin without nucleoli. The nucleus may take various forms more frequently resembling the letters U, Y, S or T. In addition, it is necessary to recognize the so called *degenerative band* with pyknotic, narrow, bizarre-shaped nucleus taking a darker or lighter stain than the typical band.

4. *Segment* The segment is a mature polymorphonuclear leucocyte characterized by a chromatin thread connecting adjacent lobes of the nucleus. The nuclear chromatin stains similarly to that seen in the band form.

In recording the differential count the following scheme is used. In the column at the extreme right under the heading *Neutrophils* appears the total number of cells that are subdivided into myelocytes, juveniles, bands, and segments.

THE SCHILLING HEMOGRAM

	WBC	Myelocytes	Juveniles	Bands	Segments	Neutrophils	Lymphocytes	Monocytes	Eosinophils
Standard Shift to left (regenerative)	7,000	1							
Depressor	20,000	12	26	4	9	90			
	5,000		21	24	20	6	53		

An increase of juveniles and band forms, usually with an associated decrease of lymphocytes and monocytes, is described as a *shift to*

¹The simplified method of staining the blood smear is undoubtedly the most accurate method of differentiating white blood cells. However, this highly specialized method requires so much time that it is hardly of clinical value to the surgeon.

the left Correspondingly, an increase of mature neutrophils usually with a restoration of lymphocytes and monocytes to normal or higher values is known as a *shift to the right*

A shift to the left with a graded increase of immature neutrophils is indicative of the active production or regeneration of white cells by the bone marrow hence this constitutes a *regenerative shift* This is the characteristic picture with an acute infection and the degree of shift to the left may be directly correlated with the extent or severity of the infection Diseases such as typhoid fever characterized by a leucopenia with neutropenia usually show a high percentage of degenerative band forms This type of reaction is the *degenerative shift*, the extreme examples of which are encountered in certain infections with a low white blood cell count and agranulocytosis or malignant neutropenia

Certain more or less physiological conditions are associated with a differential count that closely simulates a pathological blood picture. These must be kept in mind in interpreting a Schilling hemogram just as in the usual differential count We have found that the following conditions are most likely to cause confusion

1 A leucocytosis with shift to the left accompanying muscular exercise and intense emotion

2 Individual numerical variations according to age constitution and race

3 A moderate increase in the white cell count and shift to the left may be present in uncomplicated pregnancy

Most diseases and physiological conditions affecting the blood picture will fall in one of the following groups

Neutrophilia without shift (neutrophils 70 per cent or over)

1 With increased white blood cell count

a Physiological digestion (?), slight muscular activity and emotion

b Pathological superficial minor infections abortive cases of infectious diseases, hemorrhage, chlorosis polycythemia, tetanus, malignant tumors (uncomplicated) and after sodium chloride infusions

2 With normal or subnormal white blood cell counts

a Physiological changes dependent upon the uneven distribution of cells in peripheral and internal organs

b Pathological chlorosis (not constant), superficial minor infections hemorrhage sarcomatosis and malignant tumors (uncomplicated)

Neutrophilia with slight shift to left (Hyporegenerative, over 5 per cent bands)

1 The white blood cell count is usually increased but may be subnormal

a Physiological muscular activity, emotion and pregnancy

b Pathological mild infections superficial minor or encapsulated septic processes that are not extending, bacterial endocarditis, protozoan diseases, syphilis, hemorrhage, ulcerated tumors, lymphoblastoma, mildly active tuberculosis and tuberculous abscess formation

Neutrophilia with marked shift to left (Marked regeneration with juveniles)

1 Usually with increased white blood cell count

a. Physiological pregnancy, obstetrical labor and exercise.

b Pathological acute infectious diseases most of the acute protozoan diseases, acute and progressive septic processes, acute exacerbations of chronic infections and intoxications, as with carbon monoxide, heavy metal, and certain bacterial poisons.

Neutrophilia with extreme shift to left (Hyperregenerative, with myelocytes)

1 The white count may be increased, normal, or decreased

a. Physiological not found

b Pathological occurs in the most severe cases of sepsis and in disease or injury of bone marrow

Neutropenia (Absolute diminution of the neutrophils)

In these conditions the total number of

APPENDICITIS

	WBC	B	E	M	J	N	S	L	M	N
Standard	7,000						4	6	3	6
1. Chronic appendicitis	14,000						20	37	29	4
2. Acute appendicitis	8,000						9	37	3	48
3. Acute appendicitis	8,000						3	60	3	67
4. Acute appendicitis with perforation	8,000						4	37	47	7

In appendicitis the degree of shift to the left in the Schilling hemogram has been found to correlate with the severity of the infection as judged by clinical standards with greater consistency than either the total white blood cell count or the barbed differential count (2).

POSTOPERATIVE COURSE OF ACUTE APPENDICITIS WITHOUT COMPLICATIONS APPENDECTOMY WITHOUT DRAINAGE

	WBC	B	E	M	J	N	S	L	M	N
Standard	7,000						4	6	3	6
Pre-operative	8,000						1	60	3	6
1st day postoperative	8,000						7	5	8	8
2nd day postoperative	8,000						14	54	14	16
3rd day postoperative	8,000						5	37	3	58
4th day postoperative	8,000						3	6	39	57
5th day postoperative	8,000						3	4	66	3

There is decrease of the bands to slightly below normal and moderate lymphocytosis usually accompanied by slight monocytosis during the normal postoperative course of drained or removed focus of infection. The white blood cell count may increase or decrease slightly following operation. The degree of shift reflects the progress of the patient more accurately than does the total leucocyte count.

neutrophils is reduced. The leucopenia with bands and often a degenerative nuclear shift is due to reduced activity of the neutrophilic centers in the bone marrow. This picture occurs most frequently in the presence of typhoid fever, epidemic parotitis, Malta fever, grippe, chicken pox, acute poliomyelitis, sympathetic ophthalmia, and occasionally in tuberculosis.

In order to evaluate the practical usefulness of the Schilling differential count the hemogram was made a part of the routine blood examination on cases of sepsis admitted on the West Surgical Service of the Massachusetts General Hospital. These studies were performed in the routine laboratory by surgical internes without unusual training in hematology. A few cases typical of common types of sepsis are recorded below to illustrate the clinical application of this method of blood examination.

INTERPRETATION OF THE SCHILLING HEMOGRAM

The complete interpretation of the Schilling hemogram takes into consideration the distribution of the lymphocytes, monocytes, eosinophils, and basophils as well as the types of neutrophils. The monocytes and eosino-

POSTOPERATIVE COURSE OF ACUTE APPENDICITIS WITH PULMONARY COLLAPSE AND PERITONITIS APPENDECTOMY WITH DRAINAGE

	WBC	B	E	M	J	N	S	L	M	N
Standard	7,000						4	6	3	6
1st day postoperative	8,000						4	37	47	3
2nd day postoperative	8,000						4	44	34	8
3rd day postoperative	8,000						4	44	34	8
4th day postoperative	8,000						7	5	7	14
5th day postoperative	8,000						7	43	5	47
6th day postoperative	8,000						5	49	5	34
7th day postoperative	8,000						4	53	9	14
8th day postoperative	8,000						5	33	32	6
9th day postoperative	8,000						5	33	32	6
10th day postoperative	8,000						5	33	32	6

A pre-operative differential white blood cell count was not obtained in this case but the decreasing white blood cell count and increasing shift to the left suggested complication. The pulmonary collapse was reflected in the hemogram before the development of clinical signs. The increasing white blood cell count after the fourth day suggested improvement but the persistence of the shift to the left indicated residual infection. When the drain, as removed from the abdomen on the tenth day showed a culture consistent of pus drained from the focus. The increase in the white blood cell count with shift to the right the next day coincided with the subsiding infection.

APPENDECTOMY IN THE PRESENCE OF PREGNANCY

	WBC	B	E	M	J	N	S	L	M	N
Standard	7,000						4	6	3	6
Pre-operative	14,000						16	68	16	8
1st day postoperative	8,000						8	36	19	38
2nd day postoperative	8,000						3	57	3	67

Pregnancy without complication may give blood picture resembling that of pathological shift. This patient clinically presented signs in the right lower quadrant. There was no elevation of the temperature. The hemogram did not help in the differential diagnosis. There was no evidence of acute infection at the time of operation.

phils are decreased in number in advancing acute infections of surgical importance. In infection the number of lymphocytes has been found to reflect the resistance of the individual (12). Low lymphocyte counts occur particularly with advancing acute infections in patients with poor resistance. Normal or high lymphocyte count in the presence of a shift to the left is an indication of good resistance as seen in localized sepsis or chronic infection. The disappearance of neutrophils in recovery is associated with slight elevation of lymphocytes and monocytes. A transient basophilia has been noticed in postoperative leucocytosis.

The evaluation of the total white blood cell count on the basis of the types of neutrophils present is an index of the reaction of the individual to infection. An increasing shift to the left with a rising white blood cell count occurs when the individual shows an adequate response to the increased demand for white blood cells. An increasing shift to the left in the presence of a falling leucocyte count occurs with the inability of the individual to meet the

DIFFERENTIAL OF THE SCALP

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1	2	0	0	4	1	1	6	65
Pre-operative	17,100	0	0	3	10	54			0	27
1st day postoperative	7,500	0	0	0	0	54		11		35
2nd day postoperative	7,500	0	0	0	0	1	47	10		42

The presence of myelocytes with the low lymphocyte count denoted a severe infection with poor resistance on the part of the patient. However, a prompt shift to the right and an increase in lymphocytes followed drainage of the infection. A favorable prognosis was given the first day after operation that was well borne out by the subsequent clinical course.

GANGRENE OF FOOT WITH INFECTION
AMPUTATION

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000	1			0	4	64	1	6	65
Pre-operative	6,500	0		8	83	3	3	3		75
1st day postoperative	7,000	0		3	10	70	7	33	0	78

The presence of myelocytes and a large number of juveniles again is associated with a severe infection. A good prognosis was given the second day after amputation because of the shift to the right. The Schilling differential count shows only a slight decrease in the myelocytes after operation, while the total number of neutrophils is the same before and after operation. The change in the total white blood cell count is also insignificant.

RHEUMATIC FEVER SIMULATING
OSTEOMYELITIS (NO OPERATION)

	WBC	B	E	M	J	B	S	L	M	N
Standard	7,000					4	64	1	6	65
On admission	11,500	0		0	0	7	53	3	6	4
4th day in hospital	10,500	1	3	0	0	57	33	4	30	

A boy of 12 years was admitted with a swollen, red, tender area over the distal end of the left tibia. There was a less pronounced process in the same region on the right side. Clinical observations suggested osteomyelitis. The haemogram showed only a slight lymphocytosis without shift to the left, a picture absolutely inconsistent with pyogenic infection particularly in a patient of this age.

demand for white cells. Insufficient response to the infection is seen in the cases of hyper-regenerative shift without leucocytosis. The decreased demand for white cells in subsiding infections results in an increase of the mature neutrophils and a shift to the right. This shift is frequently seen with a temporary elevation of the white blood cell count as the blood returns to normal.

The progress of a patient with an infection may be very accurately followed by frequent haemograms and white blood cell counts. However, adequate surgical treatment may quickly alter the blood picture and therefore the prognosis.

USE OF THE HEMOGRAM IN OTHER CLINICS

Results similar to these have been obtained in surgical cases in other clinics. Baum has taken the haemogram as a true picture of organ pathology and has emphasized the value of repeated counts. He considers it a thoroughly reliable diagnostic and prognostic aid. Reznik

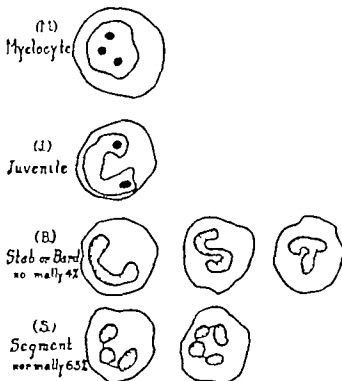


Fig. 1. Schematic representation of granulocytes as classified by the Schilling differential blood count. (After drawings by Miss Muriel McLatchie.)

Koff is in accord with this viewpoint and feels in addition that changes in the haemogram may antedate clinical symptoms. Yaguda in a study of 671 cases of appendicitis was able to correlate the degree of shift in the haemogram with the extent of the infectious process. This was also true in the 40 cases of appendicitis reported by Goodale and Manning. No shift was present in those cases in which normal appendices were found.

CONCLUSIONS

1 The Schilling differential count is readily adaptable in routine laboratory usage to replace the Ehrlich differential blood count.

2 It is of more value than the Ehrlich differential count in detecting the presence, degree and persistence of infection.

3 The Schilling haemogram is the simplest classification of neutrophils giving an adequate picture of the bone marrow response to infection.

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CLINICAL SURGERY

FROM THE LAHEY CLINIC

THE SURGICAL MANAGEMENT OF VERY SMALL AND EARLY PULSION OESOPHAGEAL DIVERTICULA

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In our experience in performing the two stage excision of pulsion diverticula of the oesophagus in some 35 patients with no deaths we have been impressed with the fact that the fair but intermediate sized type is the easiest to manage surgically, the diverticulum with a sac large enough to be readily mobilized and implanted in the wound with the dome well above the level of the skin is the simplest type to operate upon (Figs. 1 and 2).

Very large oesophageal diverticula are often difficult to handle surgically, particularly since patients with them are often in bad risks because they have not received sufficient amounts of food on account of the long standing obstruction in addition the aperture made by the opening of the diverticulum at its neck is often so large that dissection particularly on the right side may be somewhat troublesome (Fig. 2).

We have no real difficulty in treating large and intermediate sized diverticula by the two stage operation. On the other hand at the beginning of our experience we hesitated to operate upon patients with small sacs which were of insufficient diameter to permit the dome to reach above the level of the skin when implanted in the wound. With added experience however we have developed a plan whereby even the smallest diverticulum can be taken care of by the two stage procedure provided it is of sufficient size to have developed a sac with a distinct neck. We have operated upon several patients with extremely small oesophageal diverticula by the two stage plan quite safely and satisfactorily, the only one which has just been successfully operated upon is shown in Figure 3.

In our opinion it is a real advantage to be able to operate while the diverticulum is still small. Because of the technical difficulty presented by such diverticula, there has been a distinct tendency to postpone operation until the sac has increased in size. This often results in the pa-

tient's undergoing for an unnecessary length of time the discomforts associated with a sac of considerable size such as regurgitation of food, partial obstruction and—as has happened in a few of the cases upon which we have operated—interference with sleep due to the accumulation of fluid contents in the sac during slumber the contents running through the glottis into the trachea and producing attacks of choking. In 2 patients this has been one of the urgent symptoms which has prompted the seeking of relief and cases suffering from this complication should we believe be immediately submitted to surgical removal of the sac by the plan mentioned.

There has been some disagreement in the literature as to the wisdom of removing oesophageal diverticula by the one stage or two stage operative plan. As the result of our successful experience with the latter procedure as stated we do not feel like changing our method. We believe that in any large series of diverticula removed by the one stage plan there is almost certain to be an occasional one in which leakage will occur followed by mediastinitis and a fatality.

Dissection of oesophageal diverticula so that the entire neck of the sac is free and can be mobilized upward is at times difficult and requires meticulous technical precautions. Suture of the oesophagus on its posterior wall deep in the wound behind the trachea is of necessity difficult particularly since it must be done close to the pharynx where the oesophagus disappears beneath the lowest fibers of the inferior constrictor. The oesophagus ascends and descends constantly with swallowing. The oesophageal canal is always infected, and must therefore be in constant danger of leakage. We admit that with the accurate application of stitches sacs can doubtless be removed in one stage, the neck of the sac sutured and the occurrence of non fatal leakage usually prevented. Unfortunately however the situation is similar to that in all sutures of the alimentary canal.



Fig. 1. This roentgenogram shows the moderate sized sac, the ideal size for the two stage operation.

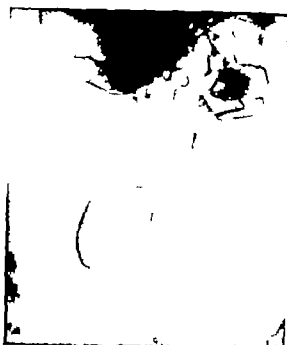


Fig. 2. This shows the very large sac in which two stage operation is very easy because the dome of the sac can be implanted well above the level of the skin but the dissection may be difficult due to the size of the aperture into the longitudinal oesophagus.

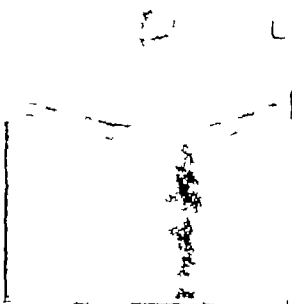


Fig. 3. This is the very small sized diverticulum concerning which this paper is written. This sac is about the size of a grape. It was in this type that up to the time of the development of this plan, operation was delayed until the sac had reached greater diameter.

through technical errors and inaccuracies—and they will occur in the very best of hands—through necrosis secondary to local loss of blood supply through inaccurate application of stitches, or through too tight ligatures, with pulling of stitches, leakage in any intestinal or oesophageal suture will occasionally happen in spite of the most painstaking attention to details. Leakage in oesophageal diverticula operations is into a fascial plane, which is admittedly a dangerous one this plane is represented in back by the pre vertebral fascia, and in front by the pretracheal fascia, and leads directly into the mediastinum. Infection occurring along it can usually be controlled by drainage but occasionally a fatal mediastinitis will occur in spite of it.

We feel strongly therefore, that the two stage procedure, in which, provided the sac is not open there is no danger of dissemination of infection along the fascial plane, with consequent mediastinitis, is to be preferred, even though it may seem less surgical and that it will in a large series of cases result in a lower mortality. As we have repeatedly stated, if one out of one hundred patients operated upon by the one stage plan died as the result of leakage, but none of an equal

number operated upon by the two stage plan we should consider this a convincing argument in favor of the latter.

With this in mind, we have been greatly interested in developing a method whereby even the smallest sac can be safely operated on by the two stage plan, thus permitting early relief from distressing symptoms and in all probability producing local conditions in the oesophagus which will bring better postoperative results. The oesophageal diverticulum shown in Figure 3 for example is about the size of a small grape. It was nevertheless successfully removed by the two stage procedure.

The surgical approach to the small pulsion oesophageal diverticulum is exactly the same as that we have described for the large diverticulum. An incision is made either transversely above the clavicle or longitudinally in front of the sternomastoid. The belly of the omohyoid is cut the middle thyroid veins are ligated and the lobe of the thyroid is turned forward. The inferior thyroid artery will seldom need to be ligated when the sac of the diverticulum is small. The sac is readily found under regional anaesthesia by asking the patient to swallow when it may readily be seen to ascend and descend in the wound (Fig 4).

The sac is picked up with tacking forceps and is carefully dissected from the overlying fibers of the cricopharyngei muscle until it is entirely free at the top on the right side at the bottom and on the left side. When the diverticulum has been completely freed as it can be with adequate exposure and retraction so that the lower angle made between the diverticulum and the longitudinal wall of the oesophagus is entirely freed, the dome of the sac is gently lifted upward and approximated to the outer edge of the sternohyoid muscle at a point such that the dome of the sac is higher than the point at which the neck of the sac joins the longitudinal oesophagus. Two black silk stitches, as shown in Figure 5 are then passed through the submucosa of the sac and the outer edge of the sternohyoid muscles. Care is taken to make certain that these silk stitches penetrate only the submucosa and do not pass through the mucosa. If they pass through all the coats of the diverticulum they may easily cut out of the sac as the result of vomiting or swallowing with consequent leakage and infection within the fascial plane. With the dome of the sac fixed between the first and second stage operations to the sternohyoid muscles at a higher level than the neck of the sac there will be no accumulation of material within the sac, the patient will

be able to swallow immediately with no regurgitation, and the distressing regurgitation of food into the larynx during sleep spoken of previously will no longer occur.

With the sac sutured to the prethyroid muscles a cigarette drain is placed in the lower angle of the wound, so that granulations and adhesions will occur behind the oesophagus in the fascial plane made by the prevertebral fascia in back and the pretracheal fascia in front thus guarding the patient against mediastinitis at the second stage operation. The wound is then closed by interrupted sutures and the sac is thus left completely buried in the wound fixed as it is to the sternohyoid muscle.

Following this stage patients swallow without difficulty can be out of bed the day after operation since it is done under novocain cervical block are immediately relieved of all symptoms of obstruction and regurgitation and may possibly go on indefinitely without difficulty in swallowing even if the second stage removal of the sac is not done. The second stage removal is however safe and simple there is always the possibility that the sac may dilate and for that reason the removal should be done.

At the end of 10 days the wound is reopened. The sac is readily discovered by following the edge of the sternohyoid muscle up to the point where the two black silk stitches which attach the sac to it are located. These stitches are cut and the sac drops away from the muscle and is immediately available for removal.

We have had no difficulty in the sac's pulling away from the sternohyoid muscle between stages no matter how small it was. The oesophagus is lax it readily dislocates to one side and any tension on the sac of the diverticulum no matter how small is we think, readily compensated for by rotation of the oesophagus and by lateral dislocation of that structure to the side on which the diverticulum sac is sutured.

With the sac of the diverticulum freed at the second stage two tacking forceps as shown in Figure 6 are placed upon the dome of the sac traction is made upon it and the neck of the sac is freed of adhesions and demonstrated. An incision with a knife is then made about the neck of the sac as shown in Figure 6 through the submucosa and what remains of muscularis down to but not through the mucosa. This incision is carried around the entire neck of the sac, a ligature of fine chromic catgut is then tied about the neck of mucosa the sac is cut away the stump of mucosa is cauterized a cigarette drain is carried down to the stump of mucosa as in an appen-

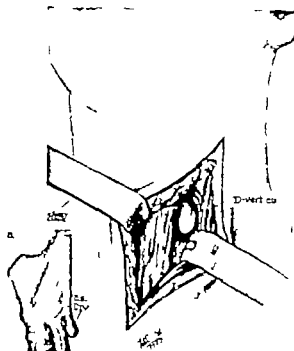
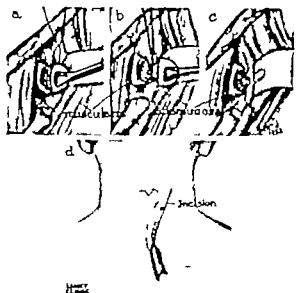


Fig 4. The main illustration shows the small sized sac dissected free and resting in the wound. Insert a shows diagrammatically the size of the small sac.



HENRY
HARRIS

Fig 6. In insert a the sac has been detached from the sternohyoid muscle. The subocoma has been incised and a ligature passed around the mucosa lining the diverticulum. In insert b this has been tied. In insert c it has been cut away as in appendectomy. In insert d a drain has been carried up to the point of ligature and emerges from the lower angle of the wound. The wound has been closed in layers about the drain.

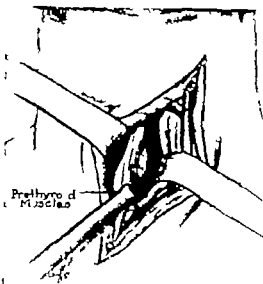


Fig 5. This illustration shows the dome of the sac dissected free and sutured with two black silk stitches to the edge of the sternohyoid muscle to fix it at this point. The wound is then closed so that the sac is buried in the wound. At the end of 10 to 12 days, the wound is reopened. The sac can then readily be discovered by following the edge of the prethyo muscles and demonstrating the two silk stitches which attach the sac to it.

dectomy and the wound is closed about the drain. This procedure has resulted in little or no leakage, and patients have usually been able to leave the hospital within 8 to 10 days following the second stage removal.

We have been interested in developing this plan of operating upon small pulsion cesophageal diverticula because of our conviction that any patient with this condition will show constantly increasing size of the diverticulum the longer he continues with it. With increase in size will come increase in symptoms, likewise lengthening years, with the patient less able to withstand surgical operation. The average age of the 35 patients operated upon for pulsion cesophageal diverticula was 58½. The youngest was 43 and the oldest 80.

As stated in all our earlier discussions patients who have been operated upon for pulsion cesophageal diverticulum should be banded after operation at intervals of 2 to 3 months for at least a year regardless of whether procedure has been by the one stage or two stage plan. One of the logical theories of the origin of cesophageal diverticulum attributes it to spasm and obstruction of the cricopharyngeal muscle fibers at the pharyngo-cesophageal junction. Furthermore whether the neck of the diverticulum be closed by a one stage or two stage procedure, there will

be some scarring on the posterior wall of the cesophagus. It is therefore desirable and not particularly disturbing to patients to pass olive tipped bougies by the point of closure at the pharyngo-cesophageal junction for the period indicated in order to dilate the cesophagus itself at this point and overcome any persisting spasm of the cricopharyngeal muscle fibers.

No patient should be dilated by bougie after cesophageal diverticulum operations unless he has previously swallowed a string so that the bougie may be accurately guided by the point of suture. Patients are given a spool of No. 7 or No. 9 silk and instructed to swallow at least 10 feet starting the day before they are to come for bougieing. Olive tipped bougies on a whale bone carrier are then threaded upon the swallowed string the string is wrapped around the finger of the person passing the bougie and stretched when the bougie readily passes the point in the cesophagus from which the diverticulum was removed and into the longitudinal cesophagus. Unless this method of bougieing upon a string guide is employed it is possible to engage the bougie

against a shelf of cesophageal mucosa and do damage by forcible pressure.

CONCLUSIONS

1. It is undesirable that patients be compelled to put up with the symptoms of pulsion cesophageal diverticulum until it has reached such a size that it can be implanted well above the level of the skin.

2. Pulsion cesophageal diverticula do not disappear but tend to increase in size and to produce more and more marked symptoms.

3. It is desirable to remove pulsion cesophageal diverticula no matter how small they are provided that they have produced a sac with a distinct neck.

4. The sac may be implanted in the wound and safely removed by the two stage procedure without the danger of leakage and mediastinitis.

5. It is desirable regardless of whether removal is by the one stage or two stage procedure, that patients be bougieed after operation every 2 to 3 months for a year and that the bougie be passed upon a string guide.

FROM THE UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE

THE OPERATION FOR PERFORATIONS OF THE
CERVICAL OESOPHAGUS

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PERFORATION of the oesophagus endangers life from infection of the mediastinum. This holds true irrespective of the location of the perforation, whether cervical or thoracic. Extravasation from the thoracic portion allows direct contamination of the mediastinal structures with such a virulent infection resulting that few patients have the resistance to survive. Efforts at surgical relief have been disappointing.

On the other hand the mediastinitis following cervical perforation is an indirect effect. It results from a dependent spread of infection from the neck into the chest along the fascial spaces. There is abundant evidence to prove that a direct communication exists between the cervical region and the mediastinum (1). This is due to the fact that during embryological development the mediastinal structures originate in the neck and migrate into the chest carrying their enveloping fascia with them. The conception that the mediastinum begins at the diaphragm and ends at the base of the skull (2) is logical since at no place is there a transverse demarcation to segregate these regions. The blocking of the paths of communication between chest and neck effectively separates the parts. If this is done before the infection has gravitated to the mediastinum then mediastinitis is prevented.

In the controversy that has arisen among endoscopists as to whether infection should be drained through the endoscope or by an external incision it would appear that this fact has been lost sight of. There is no doubt that a localized abscess beside the cervical oesophagus can be drained by the oesophagoscope. But who feels competent to predict that the infection will localize and not spread into the mediastinum? Should the oesophagus be exempt from the rules, which experience has dictated for early surgical intervention in case of perforation of other organs, as from peptic ulcer an inflamed appendix, or a traumatized urethra? It should be kept in mind that the patient does not die of the perforated cervical oesophagus, *per se* nor does he necessarily die from the infection in the neck but usually dies from mediastinitis, the indirect result of the perforation. It is possible for the surgeon to

do what nature has left undone, namely to create a transverse barrier between the neck and the chest. Thus the external operation for perforation of the cervical oesophagus will have a two-fold purpose, first to block the fascial spaces to the mediastinum and second to evacuate extravasated material.

The operation designed for this purpose was originally described by Marschlik. This procedure which has not been modified to date consists of two parts. After a long incision is made parallel to the anterior border of the sternocleidomastoid muscle the space low in the neck between the carotid sheath and the trachea, oesophagus, and thyroid gland is packed with gauze. This space is called the anterior cervical mediastinum. The dissection is carried upward, the omohyoid muscle is cut and the so-called posterior cervical mediastinum is reached. This space is between the vascular sheath laterally the prevertebral fascia posteriorly and the oesophagus, trachea, and superior pole of the thyroid gland medially. This space is packed and any extravasated material present is drained.

Palmer describes the Marschlik operation as he learned it in Hajek's clinic in Vienna as follows. An incision is made from the mastoid to the sternum. The sternocleidomastoid muscle is retracted "until the vascular sheath is reached." This is called the anterior cervical mediastinum and is tamponed with iodoform gauze. The dissection is carried upward the omohyoid is cut and by gently lifting the thyroid forward with blunt retractor the posterior cervical mediastinum is reached. The index finger may now be inserted until the cervical vertebrae are encountered. This area is tamponed and the original source of the infection is sought if the operator desires. The same description is given by Keiper (3). No mention of the operation was given in the modern textbooks or systems of surgery or otorhinolaryngology that were consulted.

The operation as originally performed in this clinic differed in a few details but not in essential principles. A smaller incision was used either transverse or parallel to the anterior border of the sternocleidomastoid muscle just above its clavicu-

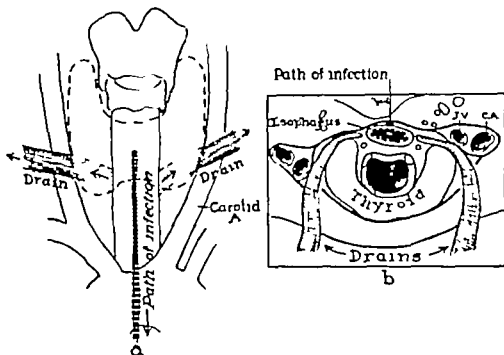


Fig 1 A diagrammatic front and cross section, b view from a case in which the standard operation was done but where infection gravitated to the mediastinum behind the esophagus. This and a similar case demonstrated the necessity of blocking the post-esophageal space

lar attachment. The omohyoid muscle was not cut. The space between the carotid sheath laterally and the trachea, thyroid and esophagus was packed down to the vertebral column in the accepted manner. The carotid sheath was occasionally opened and drained.

After several years' experience with this operation it became evident that it had two defects. The first of these is that the packing above the level of the omohyoid in the posterior cervical mediastinum of Marschik was too high. The primary purpose of this packing is to create a barrier against the spread of infection into the mediastinum. By placing it so high in the neck it is conceivably possible to block the space above the point of perforation and hence do nothing to prevent dependent drainage. But exposure of this space at a lower level is difficult because of the interposition of the thyroid gland. The obvious solution for anyone familiar with the technique of thyroid surgery is to mobilize the gland by freeing its lateral vascular attachments and turn it medially out of the way. This mobilization of the thyroid gland allows the lowest possible packing and disposes of the first objection.

The second fault in the original Marschik procedure was discovered by postmortem dissection in two cases. In one of these the operation was done but despite this the patient developed mediastinitis and died. At autopsy it was found that

the infection had tracked down *behind* the esophagus (Fig 1). A second patient who had a posterior perforation died without operation from mediastinitis. Dissection revealed no infection of the spaces which would have been packed at operation but instead a small tract of infection going down immediately behind the esophagus. From the experience with these 2 cases it was decided that the Marschik operation was incomplete in so far as the space behind the esophagus was not blocked. Furstenberg has pointed out the direct communication of this space with the mediastinum.

TECHNIQUE

The operation as it is now performed, is as follows. A 3 inch incision is made parallel to the clavicular attachment of the anterior border of the sternocleidomastoid muscle. This muscle is identified and retracted laterally after incision of the superficial cervical fascia. The dissection is carried down to the carotid sheath; the fascia and muscle fibers of the sternohyoid and sternothyroid muscles are separated, and the lateral surface of the thyroid gland is exposed. It is usually found that the gland is held down by the middle thyroid vein (Fig 2). After ligation and division of this attachment the thyroid gland is rotated medially (Fig 3). This may be all that is needed to expose the esophagus. In some instances the inferior thyroid artery may limit the retraction of

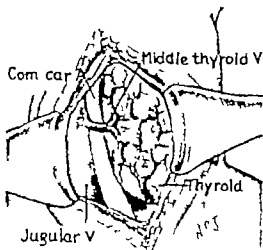


Fig. 3. The exposure of the lower cervical esophagus is usually prevented by the lateral vascular attachments of the thyroid gland.

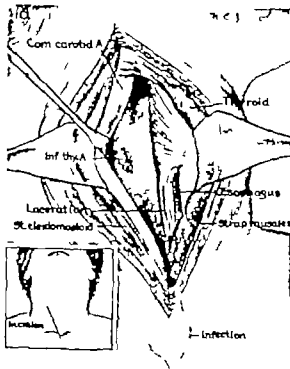


Fig. 4. A drawing made from a case of laceration of the esophagus from a clam shell which shows the exposure obtained. For clarity the drawing is made with a larger incision than that actually used (insert). The operative incision was lower and its upper angle was level with the top of the laceration. The dotted line shows the limits of dependent spread of infection. The patient recovered.

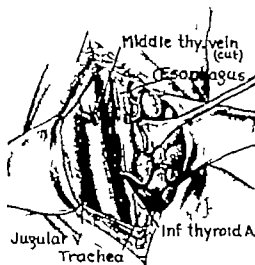


Fig. 5. The division of the middle thyroid vein and if necessary of the inferior thyroid artery permits the medial retraction of the thyroid gland. The dissection should be kept as low as the manubrium and clavicle permit.

the thyroid gland. If this occurs, the artery is doubly ligated and divided at its point of emergence from beneath the carotid. The thyroid gland may then be rotated medially and a free exposure of the esophagus obtained illustrated by Figure 4 which is made from a case operated on 40 hours after perforation of the cervical esophagus, with recovery.

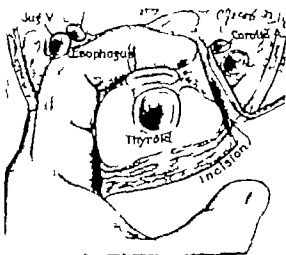


Fig. 6. A cross section which illustrates how the finger is inserted behind the esophagus to allow packing of the post-esophageal space. A bilateral incision is shown but if the process is limited to one side of the neck a single incision is used.

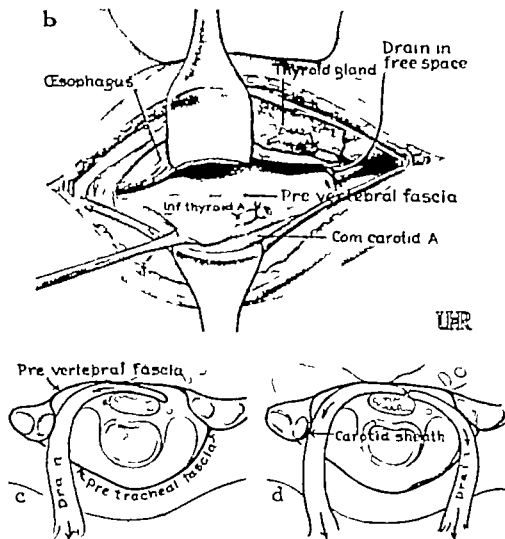


Fig. 6. b. A side view of a dissection on a cadaver to show the potential space existing behind the oesophagus. The obliteration of this space by packing (arrow) prevents dependent drainage. c and d are diagrammatic cross sections to show the position of the packing with unilateral and bilateral incisions, respectively.

After the structures have been exposed in this manner the finger is gently inserted behind the oesophagus to separate it from the prevertebral fascia (Fig. 5). This is surprisingly easy since there is only filmy areolar tissue in the post-oesophageal space. The tip of the finger is carried beyond the oesophagus to the opposite side. Gauze or a drain is then inserted with the tip extending beyond the oesophagus and brought out behind this structure then lateral to it and to the trachea and thyroid gland and medial to the carotid sheath and sternocleidomastoid muscle. If the symptoms are referable to only one side of the neck, then the operation may be terminated. If bilateral involvement is apparent, then a similar incision to that already described is made on the opposite side and a drain is inserted down to meet that already placed. This serves to pack the

fascial spaces beside and behind the oesophagus and effectively blocks all paths of spread to the mediastinum (Fig. 6).

This operation is done under local anaesthesia by regional block of the cervical nerves at the posterior border of the sternocleidomastoid muscle. A small amount of intracutaneous infiltration may be used in the line of the skin incision. The procedure does not cause shock and should involve less risk than the average operation for goiter. The choice of the skin incisions used is optional. For a bilateral dissection the transverse incision might be used. The only objection to it is the necessity for undercutting the flaps to gain exposure which opens a raw area to possible infection. The type of material used for packing depends upon the conditions found. If no infected or extravasated material is encountered then

iodoform gauze is used. If however it is desired to evacuate infected material a rubber drain is inserted since it is less apt to act as an obturator than is gauze.

The life saving object for the operation is to block the paths of spread of infection to the mediastinum. This should be done first. During this procedure extravasated material may be encountered and drained. If it is not it is debatable whether or not the point of perforation should be searched for and a drain placed down to it. It is felt that this should be decided by the circumstances of each individual case. Search for and drainage to the perforation is probably unnecessary since the infection will tend to gravitate down to the region of dissection and from there will have a vent to the outside.

The only problem in the postoperative care is to furnish adequate food and fluids while keeping the oesophagus at rest. This may be done by inserting a small catheter into the stomach for feeding. Nourishment by hyperdermoclysis vein or rectum may be given. If the perforation is large gastrostomy is probably the preferable method.

Due to the development of oesophagoscopy patients with perforation of the oesophagus are seen by the endoscopist. It is his duty to decide whether perforation exists and when external operation is needed. The burden of management is his. But we have found that close co-operation between the endoscopist and surgeon leads to a mutual understanding and appreciation of the problems involved with a consequent benefit to the patient.

Our rules for management of the various types of perforation of the cervical oesophagus have

recently been presented (2). They will not be repeated here except to reiterate the contention that since many if not a majority of perforations occur in the cervical oesophagus and since death usually occurs from the dependent spread of infection to the mediastinum and since this spread may be prevented by an operation without undue risk, then all outspoken cases of perforation of the cervical oesophagus deserve early external operation. This, in order that the surgeon may do what nature has failed to do namely to separate the fascial spaces of the neck from those of the chest.

SUMMARY

Perforations of the cervical oesophagus frequently result in a fatal spread of infection to the mediastinum. This may usually be prevented by early operation. The original procedure of Marschlik for this purpose has been modified by a low cervical exposure obtained from mobilization of the thyroid gland and by blocking the fascial space behind the oesophagus.

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BENNETT'S FRACTURE AND OTHER FRACTURES
OF THE FIRST METACARPAL

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EDWARD HALLORAN BENNETT was professor of surgery at Trinity College, Dublin. He was born in Cork, April 9, 1817. His medical education was obtained at Trinity College from which he received the degree of M.B. in 1859. He was immediately appointed demonstrator of anatomy from which position he rose rapidly and in 1864 succeeded J. K. Barton as University anatomist. While in this capacity he made use of the wealth of material at his disposal and was able to collect sufficient specimens of bone injuries to speak with authority in this field of bone pathology. In 1863 he became a fellow in the Royal College of Surgeons, was soon made councillor and in 1884 became president. He was one of the promoters of the union of medical societies in Dublin which resulted in the formation of the Royal Academy of Medicine of which in 1897, he became president. His labors in general surgery were obscured by his special interest in bone disease.

To his fellow practitioners he was always a model of honor and uprightness. No one ever heard it said that Bennett did a crooked thing. He was blunt, sometimes emphatically so, but he always said what he believed to be the truth although that might not be pleasant to hear. He was a man of strong personality and in his criticisms of other men's work he was very outspoken but never unfair. He never said an unkind word of anyone. He was thoroughly straightforward in all his ways and he detested anything underhanded. The result was as might be expected that no man had fewer enemies or more friends.

His manner toward the poor patients in the hospital was gentle to a degree while his fondness for children was proverbial so that he was a great fa-

vorite with them. He was a man of retiring habits and his figure was rarely seen on public platforms or at great social gatherings.

He loved teaching the students in the hospital wards, were they the most junior or the most advanced and nothing did he enjoy more than discussing with them some difficult case or propounding some points of diagnostic interest. His liveliest interest lay in the diagnosis and the pathology of rare fractures. He had a facility for awakening the interest of students and of attaching them to him as loyal and believing followers. If he some times appeared brusque in manner or in tone his students knew he was at heart generous, encouraging, a just and tolerant judge, a man devoted to their interests and always helpful in those things that led to their success.

He was the colleague of men who seem to have directly inherited and brought to their profession in a later day the manners of eighteenth century Dublin—a culture that went hand in hand with a kind and robust humanity. He maintained while availing himself of modern scientific resources, the attitude toward life of a generation who were

never forgetful of the high import and dignity of their profession and who never allowed science to defeat its object or leave them too well equipped but too little capable. He was dignified without pedantry and cultured without arrogance.

When he lectured as university professor, he came to treat of surgery, having at his command the resources of literature and a great and nice knowledge of the Classics. His lectures were learned and academical far removed from mere recitals of facts that under the name of science become impersonal and inorganic because they lack the teacher who can assimilate and subordinate them.



Edward Halloran Bennett—1837-1907

to their proper ends of humanity. One could see with what reverence he esteemed his calling if only from the respect and enthusiasm with which he always spoke of the work of his colleagues or his predecessors. He would dwell on names well known in medicine with admiration and revivify them with his own personality until the pupils on the benches shared his enthusiasm.

Before the advent of X-ray examinations, the diagnosis of bone injuries was based on a careful consideration of the nature and manner of the trauma, the symptoms noted by the patient and the physical findings derived after patient and diligent examination. The establishment of a pathological entity or type of fracture was accomplished by the accumulation of specimens in the pathological museums of the medical schools and large hospitals. A correlation of the clinical findings with the illustrative pathological specimens served as a basis for the establishment of a clinical entity.

As an example of the foregoing the fracture described by Bennett and since then known as Bennett's fracture may be cited. While the use of proper names has been grudgingly condoned in recent medical literature no greater tribute to the painstaking efforts of the surgeons of the pre-roentgen era can be conferred than the retention of the name of this observer as an object lesson to present day students whose work has been greatly simplified by the use of roentgen ray examinations. A perusal of the writings which called the attention of the profession to this lesion is worthy of our consideration.

In 1881 Bennett exhibited before the Dublin Pathological Society a series of united fractures of metacarpal bones, 9 in number all from the right hand of which 5 were fractures of the first metacarpal bone. Concerning these 5, he stated:

I each of the five examples of fracture of the thumb allowing for shades of difference such as must always exist, the type and character of the fracture is always the same—form and type of fracture not hitherto described in these bones. The fracture passes obliquely (a.k. in the cut) (Fig. 1)

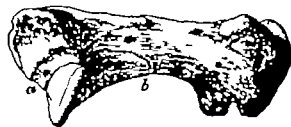


Fig. Original cut illustrating Bennett's fracture

He had a wider experience than the generality of men and a wider humanity. He knew life well and the more he learned of it the more he admired it. His insight did not sour him for his was a great sanity. He was kind and forbearing—intolerant only of pretense.

He died in Dublin June 21 1907 in his seventy first year.

through the base of the bone detaching the greater part of the articular facet with that piece of the bone supporting it, which projects into the palm. In all these specimens, the dorsal surface of the bone is free from any implication in the fracture, and this fact, combined with the small amount of displacement which occurs, rendered the fracture one extremely liable to escape detection.

So trivial an injury does this appear to be and the specimens show so little deformity except in some the signs of arthritis consequent on it, I might fairly be asked what importance attaches to the correct diagnosis. All will admit that a correct diagnosis even in trivial injuries is desirable but in this case the diagnosis is essential to a correct prognosis and here lies the importance of the injury. Seeing the value of the movements of the thumb no injury of it is to be lightly regarded and this fracture though it united readily by bone and with almost inappreciable deformity renders the thumb for many months lame and useless.

At the annual meeting of the British Medical Association held in Cardiff July 1885 in an address delivered at the opening of the section of Surgery Bennett stated after showing the importance of assembling specimens of fractures:

The small size of the bones and the light value, clinically which we surgeons have been apt to assign to simple fractures of the metacarpus, delayed my study of them, and so, perhaps, the result has been all the better for, without some time spent in accumulating, a number sufficient to attract attention could not have been reached. Taking at last the group into closer study I was struck by the fact that one particular fracture outnumbered all others. Now if we look to the series before us, remarkable fact is disclosed. Amongst these fractures, there occur six examples of fracture of the base of the metacarpal of the right thumb, and no others of this bone. In each of these the injury is the same. Most remarkable is the fact that in every case the accident has been on the right side of the body. Certainly this injury once we know of its existence becomes vastly more common than any other of the metacarpus. If left to itself it unites with such deformity as this case shows, trivial deformity after all. Why then deem the matter worthy of the notice of this surgical section of the British Medical Association. Simply for this reason, that I had ample proof that a hand so injured remains under the best of treatment long disabled and without treatment for a greatly longer time. When we consider the value of the right thumb to anyone who lives by handicraft or indeed to any rich or poor we should not let unnoticed and undiagnosed this common injury.

In the *British Medical Journal* of July 3 1886 Bennett published a résumé of his previous articles reported in 1882 and 1885. He stated:

I now write this short note to make a correction in my account of the injury which, though of secondary impor-

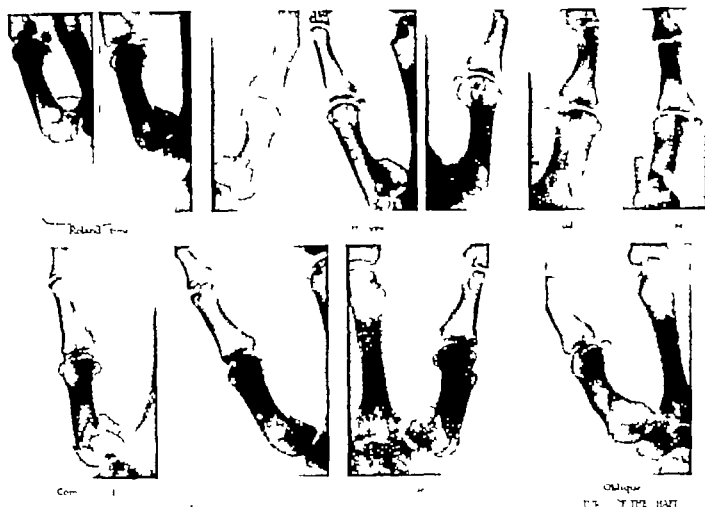


Fig. 2. Types of fracture of first metacarpal bone

tance only. I prefer to make myself rather than have it made by another. I stated that every example I had seen in the living or dead occurred in the right thumb. I avoided committing myself to the assertion that it could not occur on the left side. I merely said "most remarkable is the fact that in every case the accident had been on the right side of the body." I am now able to supply a drawing taken from a left hand deformed by the fracture and to record the observation of two other examples on the left side in patients seen this season in Sir P. Dunn's hospital. Thus I hope to correct whatever of error might have arisen from my record of my experience in August last.

The views expressed by Bennett concerning the importance of the thumb have not changed since his era. This is well exemplified by the fact that the State of Illinois Industrial Commission regards the value of the thumb as 60 weeks out of a total value for the entire hand of 185 weeks. Thus practically one-third of the value of the hand is vested in the thumb on the basis of utility in manual work.

Not all fractures of the first metacarpal correspond to Bennett's description. There has been considerable confusion of terms in descriptions of fractures of the first metacarpal and the classi-

fications listed below summarize the various types of fractures of this bone (Fig. 2)

- I At the base
 - a. Intra-articular
 - 1 Bennett type
 - 2 Rolando type
 - b. Extra-articular
 - 1 Transverse
 - 2 Oblique
 - 3 Complicated
- II The shaft.
 - 1 Transverse
 - 2 Oblique
 - 3 Longitudinal
- III The head
 - 1 Transverse

Winterstein cites some interesting statistics on the relative distribution of fracture sites in 200 cases of fracture of the first metacarpal.

29 per cent Bennett type	} Base 80 per cent of all
7 per cent Rolando type	
10 per cent extra-articular—oblique	
25 per cent extra-articular—transverse	
9 per cent complicated—several varieties	

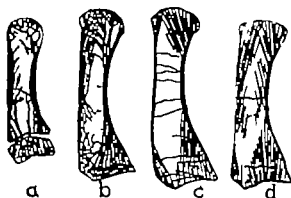


Fig. 3. Internal architecture of first metacarpal bone (after Magliulo)

1 1/2 per cent oblique	} Shaft
per cent transverse	
per cent longitudinal	
2 1/2 per cent transverse	} Head
5 per cent evulsion of capsule	
3 1/2 per cent epiphyseal fracture—Bennett	
2 per cent sesamoid bone fracture with head	

These fractures were divided

60 per cent in right hand, 9.5 per cent in men. It was found that direct trauma was usually of occupational origin while indirect trauma was due to falls, manipulations of thumb etc.

ANATOMICAL DESCRIPTION

The first metacarpal bone presents a body, a distal extremity or head and a proximal extremity or base. The body has a radial and an ulnar border. The palmar surface gives attachment to the muscles of the thenar eminence while the dorsal surface is flat with a rounded extremity toward the base. The proximal articular surface is saddle shaped with a dorsopalmar concavity and a slight lateral convexity. The dorsopalmar concavity presents a dorsal portion which lies in a straight line with the body of the metacarpal and a palmar portion which projects outward from the body of the metacarpal at an angle.

Corresponding with this gross anatomical description is an internal architecture made up of layers of lamellae which assume a definite shape and to a great extent determine the deformities produced when fracture occurs. Recent studies of Magliulo have clearly brought out the internal structure of the bone in the various age groups.

In adolescents (Fig. 3a) the diaphyseal cylinder is rather thin and little developed at the base. Two systems of lamellae are seen—a posterior and an anterior of almost equal dimensions. Although these lamellae are interrupted by the incomplete

ossification they retain the volodorsal direction in the posterior part. The lamellae are very thin at the head of the metacarpus but an arched bundle passes from the volar part of the neck to the back.

In adults from 20 to 27 years (Fig. 3b) at the base the anterior system of lamellae becomes triangular in form and is more robust than the posterior group which is much smaller and made up of a few very thin lamellae. The head preserves also the arrangement of the two systems of trabeculae that is the anterior and posterior systems.

In adults over 27 years (Fig. 3c) the compact tissue of the diaphyseal cylinder is generally thicker and the thickness is greater on the volar or concave than on the dorsal face where with advancing age, the compact tissue becomes thinner and finally changes to a thin dorsal layer (Fig. 3d). At the base the anterior and posterior systems of lamellae are preserved except that the posterior system is small and the start of rarefaction of the spongy tissue of the epiphysis is present. The compact tissue of the dorsal surface thins to only one lamina while in the volar surface it has a greater thickness. At the base, the anterior triangular system is present while the posterior system is lacking having been replaced by areolar tissue. At the head only the anterior system is well developed.

From the foregoing it may be seen that the bony tissue of the diaphysis of the first metacarpus in the various ages is more developed in the anterior surface than in the posterior surface. At the base in all ages there is a system of trabeculae in dorso-volar direction with lamellae which are parallel to one another which form in their entirety a bundle, triangular in shape, the base of which occupies four fifths of the articular surface and the apex of which lies on the concave surface of the metacarpus at the point of union of the diaphysis with the superior epiphysis.

MECHANISM OF FRACTURE

In describing the mechanism of fractures into the proximal joint, Rolando states that the dorsal articular process presents a much greater resistance to external violence than the palmar articular process, especially in injuries which act in the direction of the longitudinal axis of the metacarpal. The effect of this violence is to render the angle formed by the palmar articular process with the palmar surface of the metacarpal more acute. This results in an oblique fracture at the base of the process. The fracture then radiates from a point near the center of the articular surface to the

palmar surface. This is the mechanism by which Bennett's fracture is produced. The anterior triangular system of trabeculae previously described are practically sheared off from the shaft of the bone. In this fracture the dorsal articular process and the body of the bone tend to become dislocated dorsally but this dislocation can only be incomplete if the ligaments uniting the trapezium with the metacarpus are intact. In those cases in which violence is very severe or long continued and is in the longitudinal axis of the metacarpus it may lead to a fracture of the more resistant or dorsal articular process. In these cases there is a Y fracture in which the upper extremity of the first metacarpus is divided into three fragments two of which correspond to the base and are dorsal and palmar while the other corresponds to the shaft of the bone. This type is known as the fracture of Rolando. The articular fragment on the palmar surface constantly turns toward the thenar eminence. The dorsal articular fragment retains its relations with the trapezium. The lower fragment of the diaphysis may present a dorsal luxation as in Bennett's fracture or there may be no dislocation.

The two types of intra articular fracture that of Bennett and that of Rolando correspond to fractures along the internal lamellae of the base.

The mechanism of production of fractures of the first metacarpus has been investigated experimentally on the cadaver. Magliulo found that in 9 experiments where the thumb was abducted and slightly extended a blow on the dorsum resulted in fractures of the Bennett type in 4, fracture of the trapezium in 1, laceration of the ligaments in 1 and no result in 3.

He concluded from his work that the mechanism of fracture depended upon (1) the architecture of bone (2) the age of patient (3) the degree of extension and flexion (4) the action of trauma.

The treatment of fractures of the first metacarpal is of importance because of the associated pathology which develops. Faulty union atrophy of muscles of the thenar eminence weakness of the grip all contribute to the disability which may follow a simple fracture. In all of the extra articular types fixation in a position of extreme abduction will retain the web of the first metacarpal space and permit abduction when the splint is removed.

In the Rolando type of fracture simple abduction is usually sufficient to produce approximation of the fragments of bone. The prognosis in this type of fracture is better than in the Bennett type because of the usual absence of upward dislocation of the shaft found in the latter.

In the Bennett type the prognosis being not so favorable special effort must be directed to overcome the pathological displacement. In addition to the extreme abduction suggested for the other type of fracture longitudinal traction is essential if upward dislocation of the shaft has occurred. Many interesting procedures have been devised with this object in view.

Lambotte in 1908 produced osteosynthesis by nailing together the fragments. Imbert and Cotlaroda in 1923 reported their procedure of osteosynthesis which did not differ radically from Lambotte's method. Baun used a nail driven through the distal fragment for the purpose of longitudinal traction.

Recently the incorporation of a wire loop in a plaster cast about the wrist has been utilized as a means of support for longitudinal traction produced by means of adhesive strips and rubber bands.

SUMMARY

Fractures of the base of the first metacarpal bone are most numerous occurring in approximately 80 per cent of all fractures of the first metacarpal bone. Only one fourth of these conform to the description of the Bennett type of fracture. This type of fracture is important because of the functional disability which follows when the fractured bone is allowed to heal without replacement of the fragments in correct apposition.

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ADENOMA OF THE AMPULLA OF VATER

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BENIGN tumors involving the extrahepatic bile passages are extremely uncommon. A careful search of the literature discloses but 41 cases the author adds 1 case. The authenticity of some of the earlier cases is somewhat open to question. Including the author's case, the relative frequency of the different types of tumors is papilloma and polyp 16 adenoma 15 lipoma, 4 fibroma, 2 neuroma, 2 granuloma, 2 melanoma (classified as benign) 1, carcinoid 1. Practically all the patients afflicted were of middle age or older. Most of them had an associated jaundice and other obstructive symptoms. In 6 cases the tumor seemed definitely to involve the ampulla of Vater. In some cases the tumors were successfully removed at operation and in a few the tumors were found by chance at autopsy. It is noticeable that the lesion has been given increasing recognition in the last 50 years.

In their discussion of this subject, Savy, Bonnet, and Martin¹ state that "epithelial tumors constitute the great majority of benign neoplasms of the biliary passages they are represented by a hyperplasia of the glands, or the epithelial surface which becomes papillomatous. They are adenomata or papillomata. All benign tumors of the biliary passages, whatever their site, have two principal characteristics they are associated with a previous state of inflammation and they have a tendency toward transformation into cancer. According to Rolleston and McNee² the simple papilloma occasionally seen around the biliary papilla in the duodenum are growths of the intestinal surface of the papilla and not of the bile duct. Papilloma may however arise in the cavity of the ampulla of Vater.

The pre-operative diagnosis of benign tumor of the extrahepatic bile passages is probably never made. Carnot³ says "In the presence of jaundice which is at first intermittent and later continuous operation is always to be recommended. The diagnosis lies between biliary calculus and tumor of the ampulla of Vater. If the gall-bladder is large, it is more likely to be a tumor. If it is small and there is pain it is more likely to be a stone." When there are clinical signs of biliary obstruction and at operation the common duct is

found to be dilated it will be necessary for the operator to satisfy himself as to the presence or absence of a benign tumor of the common duct or ampulla of Vater. Even if a calculus is found, a benign tumor may be present (see Rolleston's case). If the presence of a tumor of the orifice is suspected it generally will be necessary to open the duodenum. Benign tumors may be removed by excision, curette or cautery and the prognosis may be excellent.

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In the following case there was an adenoma situated in the ampulla of Vater

I. F. B. female aged 74 years, entered the Evanston Hospital on February 5 1932. There was a history of severe abdominal pain and vomiting of 12 hours duration and a possible previous history of cholelithiasis. The pain was chiefly epigastric and somewhat more on the right. Two enemata were unsuccessful. There was marked rigidity of the upper half of the abdomen. The temperature was 97.5 degrees, the pulse 92 respirations 30, leucocyte count 20,750. The urine showed a faint trace of bile a faint trace of albumin and rare red blood cells. Three hours after admission an exploratory laparotomy was done under ethylene anesthesia with the most probable diagnosis perforation of the gall bladder or stomach. Through a right paramedian incision the transverse colon and stomach were found to be normal to inspection and palpation. There was no evidence of tumor mass in any part of the abdomen which was carefully palpated. The only region which presented any pathology was the under surface of the liver. In this region there were old dense adhesions which completely covered the gall bladder and obscured it from view. The duodenum was adherent in this region. The gall bladder was finally exposed by careful tedious dissection of these adhesions. It was found to be about 2½ inches in length and presented two constrictions in its proximal half. By following down the cystic duct an enormously dilated common duct was disclosed. This structure was at first thought to be duodenum but dissection and aspiration insured its identification. The gall bladder was opened, four small gall stones were removed and drainage was instituted. The common duct was opened and a probe apparently passed into the duodenum over a roughened or somewhat obstructed part which seemed to be in the region of the ampulla of Vater. No stones were found in the common duct by the scope. In view of the advanced age of the patient and her condition on the operating table further exploration of the region of the ampulla of Vater was omitted. A T tube was sutured into the common duct and a single rubber tube was inserted in the gall bladder. A cigarette drain also was used.



Fig. Photomicrograph of adenoma of the ampulla of Vater. The darkly stained pancreatic tissue is seen in the lower half. The tumor is in the upper half projecting into the lumen of the common bile duct, a portion of the mucosa of which may be seen at the left.

The patient did very well after the operation except that the bile flowed externally instead of into the duodenum. Accordingly a second operation was done on February 24, 1932, 9 days after the first operation. At this operation a nigger was easily inserted into the common bile duct and with gentle pressure seemed to pass through the sphincter at the ampulla and enter the duodenum. A rubber catheter with extra holes in it was now placed in the common duct so that 4 or 5 inches of it protruded into the duodenum distally from the ampulla. This was anchored to the skin by silk suture. The common bile duct was closed around this suture and cigarette drain was placed. The patient went through this operation surprisingly well but bile continued to escape from the wound and none seemed to enter the bowel. Moreover duodenal contents escaped from the wound. After some 5 or 7 days, the wound broke down and was opened widely. A fecal fistula, apparently originating from the colon, appeared on the fourteenth day. The patient became rapidly weaker and died the eighteenth day after the second operation.

A postmortem examination was made by Dr. F. D. Gunn, pathologist, Evanston Hospital, who discovered an enormously dilated common bile duct, the circumference of which was 6 centimeters, at the level of the isthmus. The right hepatic duct had maximum circumference of 2 centimeters. His report continues as follows:

The gall bladder is shrunken down to the size of small pecan. There is a 3 millimeter sized opening in its fundus which is partly surrounded by fibrous adhesions. The mucosa of the gall bladder is pink and about 2 millimeters

in thickness. The lumen contains only a small amount of brownish mucus.

At its lower extremity the wall of the common duct is thickened and indurated. One 5 millimeter sized granular tumor-like nodule and several minute granules resembling granulation tissue project into and encroach upon the lumen. A 1 millimeter sized probe passes through the ampulla without forcing it. There is, also, a slit-like opening admitting the tip of the little finger which leads from the lowermost portion of the dilated segment of the common duct (about 1 centimeter from the ampulla) into the duodenum. At a distance of about 1 centimeter distal to the ampulla, there is a lentil-sized nodule beneath the mucosa of the medial wall of the duodenum.

Microscopic findings. Ampulla of Vater: The granular mass which was found projecting into the lumen of the common bile duct at the ampulla is composed of a mass of gland like epithelial structures embedded in dense fibrous tissue and smooth muscle. They differ strikingly from the Brunner's glands, near which they lie, in that they are much simpler, more like embryonal structures and consist mainly of simple or branching tubules. A few of them show cystic dilatation, proliferation and desquamation of their columnar epithelium. No definite malignant changes are observed. The fibrous stroma is lightly infiltrated with lymphoid cells and eosinophils. The overlying duodenal mucosa shows postmortem digestion. A similar destruction of the lining of the ampulla is apparent.

Anatomical diagnosis. Chronically inflamed adenoma of the ampulla of Vater with stenosis of the lumen of the common bile duct. High grade dilatation of the common bile duct and of the hepatic ducts. Chronic fibrous cholecystitis with contraction of the gall bladder. Recent surgical wound of the upper part of the abdominal wall (right rectus incision). Small surgical fistula between the fundus of the gall bladder and the floor of the abdominal wound. Surgical fistula of the common bile duct opening into the floor of the abdominal wound. Adenoma of the duodenal mucosa. Fatty infiltration of the pancreas. Brown atrophy of the heart. Hypostatic congestion and early lobular pneumonia of both lower pulmonary lobes. Small adenoma of the cortex of the left kidney.

SUMMARY

1. A case of adenoma of the ampulla of Vater is reported.

2. A survey of the literature of benign tumors of the extrahepatic biliary passages is presented.

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CONGENITAL HYPERTROPHIC STENOSIS OF THE PYLORUS

A STUDY OF FOUR HUNDRED AND TWENTY FIVE CASES TREATED BY PYLOROMYOTOMY¹

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TO justify surgical measures for the relief of any condition certain facts must be established. First and most important can these surgical measures be made safe enough to justify the risk, not only of the operation itself but of the incidental dangers attendant on any major surgical procedure? Second are the end results of such surgical measures satisfactory?

In this hospital the surgical treatment of congenital hypertrophic stenosis of the pylorus has for many years been regarded as the treatment of choice. This series of 425 cases covers the period from 1915 to 1931. In all cases pyloromyotomy (Fredet-Rammstedt type) has been employed. Study of the results in this series establishes the safety of surgical treatment and also the fact that there is prompt and lasting relief of symptoms. The factors that we have found to be of importance in minimizing the mortality are emphasized.

MORTALITY

In Table I the total mortality in the series is shown to be 6.3 per cent. Of greater interest however, is the reduction in mortality from 10.4 per cent in the first 125 cases to 7 per cent in the next 150 cases and in the last 150 cases a further reduction to only 2 per cent. From the early part of 1930 up to the present time, June 1932, there have been no deaths.

The measures that have made possible this reduction in mortality have to do almost entirely with the differences between the surgical treatment of the small patient and the adult. In infancy or childhood all surgical procedures carry much higher proportionate risk both operative and incidental. In congenital pyloric stenosis the technical difficulties of the operation itself are few and in competent hands should be as slight as in any abdominal operation. Indeed the apparent simplicity of this operation has been the source of considerable danger to these patients for as Barrington Ward states in the preface to his *Abdominal Surgery of Children*: "The adult may be safely treated as a child but the converse can lead to disaster."

The causes of death in this series are included in two main groups. In the first group are those incident to the technique of the operation itself

and include operative and postoperative hemorrhage, wound infection and peritonitis. In the second group are those causes due to the undernourished and dehydrated condition of the patient which adds to the danger of postoperative shock and collapse. A predisposing factor to infection and leads to unsatisfactory healing of the wound. Such a condition also makes difficult the postoperative establishment and maintenance of the adequate nutritional and fluid needs of the patient.

In the operation itself extreme care must be observed that all hemorrhage in the abdominal wall incision be absolutely controlled. A right rectus muscle splitting incision about 2 inches long with its midpoint at the edge of the liver is used. The liver edge is the important landmark, not the costal margin. In making the incision in the pylorus the bloodless area is selected. The upper and posterior surface of the pylorus is the point at which there is the least blood supply. The pylorus must be delivered into the wound and its upper and posterior surface rotated outward and slightly downward to expose this area for incision.

Hemorrhage from the pyloric incision is usually slight and is easily controlled by hot saline packs. If not controlled by these means the bleeding point must be sutured with fine silk on a non-cutting needle. A clamp or tie will usually cut through the rather hard and friable tissues. If suture does not control the bleeding a piece of the rectus muscle should be sutured over the bleeding points. The greater incidence of hemorrhage from the pyloric incision in patients over 6 weeks of age has been an interesting observation in this series and will be considered in greater detail in a later paragraph.

Peritonitis may result more often from an operative perforation of the duodenum than from

TABLE I.—SUMMARY OF CASES

Years	Serial number	Number of cases	Deaths	Mortality per cent
1915-1923	1-125	125	13	10.4
1923-1928	125-275	150	11	7.0
1928-1931	275-425	150	3	2.0

¹ From the Surgical and Medical Services of the Children's Hospital and Infant Hospital, Boston, and the Departments of Surgery and Pediatrics, Harvard Medical School.

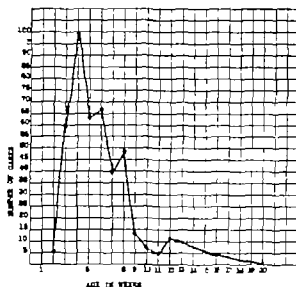


Chart 1. Age at which hospitalization began.

a break in aseptic technique. The greatest care is necessary in making the incision at the duodenal end of the hypertrophied pylorus. It is here that the hypertrophied pylorus terminates abruptly at the duodenum which is extremely thin. Perforation of the duodenum is easy but avoidable. If perforated, the hole in the bowel wall should be closed at once with a silk stitch. In this series, the duodenum was perforated three times but in only one case was there a fatal peritonitis. Peritonitis may also be the result of operating near or through an infected field. In one case in this series there appeared to be a definite relation between an omphalitis and a later postoperative peritonitis. Peritonitis may also be a metastatic affair the result of a bacteremia or septicemia, secondary to other foci of infection, usually an upper respiratory infection. In 2 cases in this series, a peritonitis occurred in poorly nourished infants from 16 to 30 days after pyloromyotomy, despite the fact that vomiting had ceased. The peritonitis was undoubtedly a metastatic one.

The lowered resistance and resulting diminished power of healing in these patients requires the most rigid asepsis and hemostasis, also the most meticulous care in approximating the abdominal incision layer by layer. Postoperative evisceration following delayed healing due to imperfect approximation, low grade infection, hematoma, or combination of any or all of these factors may occur. In this series, in 3 cases, the incision reopened on the fifth to the seventh day. There

were 2 deaths. Deaths due to operative peritonitis, hemorrhage, evisceration are largely preventable and in our series accounted for 6 or 22 per cent of the total mortality. The remaining deaths were classified under such headings as malnutrition, "collapse" and acute nutritional disturbance. The causative factor in a large majority of these cases was the patient's undernourished and dehydrated condition, and the inadequate measures taken to combat it, both before, during, and after the operation. Important as is the proper operative technique the adequate pre-operative and postoperative care is even of greater importance in reducing the mortality rate. Seventy-eight per cent of our total deaths were due to causes other than faulty operative technique.

The steady decrease in our mortality rate has been concomitant with a longer pre-operative stay in the hospital. This longer pre-operative stay is not inclusive of the period of observation that certain cases received before diagnosis was established. The longer pre-operative period represents the time spent in overcoming the dehydration of these patients.

THE PRE-OPERATIVE CARE

Pre-operative care must be based on reason and not on any routine procedure. The operation is not an emergency. Where early diagnosis is made much less in the way of pre-operative care is required. However in the majority of these patients, vomiting has caused a loss in body fluids and has caused a loss in blood chlorides, which may result in alkyllosis. The starvation incidental to prolonged vomiting has caused a depletion of the glycogen reserve in the body with its resulting ketosis.

Dehydration must be combated by salt solution given by hypodermoclysis. This supplies fluid for the depleted body tissues and aids in the restoration of electrolytes lost by persistent vomiting. Intravenous administration of glucose solution while not providing directly for the loss of body fluids, does account for the removal of ketone acids, and promotes re-establishment of renal function. At this hospital it is usual to give 10 per cent glucose solution intravenously and normal saline by hypodermoclysis. In the extremely cachectic patients we give in addition a blood transfusion, 10 cubic centimeters per pound of body weight. Blood transfusion is now found advisable in only about 5 per cent of the patients treated. Twenty-four to forty-eight hours is time well spent in combating dehydration before operation.

Next in importance is the prevention of loss of body heat. Exposure contributes proportionately more to operative shock than in older patients. The field of operation exposed though actually small, is proportionately a much greater surface area than in adults. The patient is placed on warm blankets beneath which some form of heat may be constantly applied. The legs, arms and chest should be wrapped in flannel bandages.

POSTOPERATIVE CARE

After operation the infant should be immediately dried and redressed in warm coverings and the body heat constantly maintained. The postoperative feedings by mouth cannot at first be sufficient to meet either the caloric or fluid needs as the effects of dehydration may still be present. The following method has proved effective in our hands.

3 hours following operation, 1 ounce of sterile water
2 hours later 1 ounce of sterile water
2 hours later 1 ounce of whey Repeat at 2 hourly intervals for 3 feedings.

2 hours later $\frac{1}{2}$ ounce of whey and $\frac{1}{4}$ ounce of breast milk.

Repeat for 3 more feedings. Then decrease whey by 1 dram for each feeding and increase breast milk by 1 dram until whole breast milk is taken.—1 ounce.

Breast milk is then increased by dram amounts each 2 hours until such time as the patient is getting $1\frac{1}{2}$ ounces each feeding. The next procedure is to lengthen the interval and increase the amount, and finally to change to a modified milk formula if the mother's milk is not available.

(A suitable breast milk substitute is used from the start if breast milk is not obtainable.)

This schedule of feeding by mouth does not meet either the caloric or fluid needs of the infant for the first few days. It is unwise in the usual case to attempt to meet them by feeding by mouth before the fifth day after operation. It is, therefore necessary and most important during this period, to supplement the oral intake of fluids by rectal taps, hypodermoclysis of salt solution, or the administration of intravenous glucose. The infant should receive and retain 3 ounces of fluid per pound of body weight each 24 hours, and the chloride and glucose requirements of the individual patient must be met. In this series, 5 of the 27 deaths were attributable to faulty operative technique. This number should, of course, be still further reduced until the irreducible minimum be reached beyond which the human element cannot go. In the private practice of the staff the mortality is negligible. In a hospital series, the poor risks are always present and their number will decrease

only as a greater number of cases are recognized early and proper treatment instituted. But there is great need of recognizing that the poor operative risks can be brought into much better condition to withstand surgery than was formerly the case.

Our reduction in mortality from 10.2 per cent in 1915 to 1923, to 2 per cent in 1928 to 1931 was not entirely due to more skilled and experienced operators but rather to better pre-operative and postoperative care. There was only one operative death in which the operator had had only small operative experience in these cases—death in this case being due to hemorrhage from the pylorus.

ANÆSTHESIA

Ether given by the open drop method seems to us the anæsthetic of choice. Gas and oxygen avertin, supplemented by gas and oxygen, or ether all have their place. Novocain alone has not been used in this clinic for 4 or 5 years. It adds to the risk by prolonging the time of operation and may interfere with healing of the wound. Ether was used in 98 per cent of the patients in this series. In no instance did death occur on the table, nor was there any postoperative complication that could be directly traced to this anæsthetic.

Of the 27 deaths in this series, 9, or 33½ per cent occurred in patients under 6 weeks of age. There were 294 cases or 69 per cent of the series in which operation was done before the patients were 6 weeks of age. This gives a mortality of 3 per cent in the younger group. Eighteen deaths or 66.6 per cent of the total mortality, occurred in the group of patients who were over 6 weeks of age. This gives a mortality of 13.7 per cent for the 131 cases in the older group. In addition to carrying a much higher mortality, this group also includes a large number of cases in which hemorrhage from the pyloric incision was greater in amount and often required additional measures for its control.

In none of our cases was there any doubt as to the existence of a true hypertrophy of the pyloric fibers, but it was very noticeable that the older patients who had had a longer period of symptomatology did present a more vascular pyloric ring. A higher mortality in the older age group has been noted by other writers. It is our belief that the greater vascularity of the pyloric ring may be due to a superimposed element of pylorospasm which although present to some degree in all cases is increased as a result of prolonged symptomatology. When true hypertrophy of the pyloric ring is present, medical measures will

not effect as safe and as prompt a cure as pyloromyotomy. The greater morbidity and mortality in this older group plus the fact that all of them had a true hypertrophic stenosis convinces us that early surgical treatment should be instituted, that it will carry less danger to the patient, and result in quicker relief of symptoms.

RELIEF OF SYMPTOMS

In practically all cases relief of symptoms has been prompt and lasting. We have been able to observe a sufficient number of cases over periods of 4 to 12 years to feel sure of this fact. In 2 cases a secondary operation was done because of persistence of symptoms. One of these had been operated upon previously at another hospital. The findings at this second operation revealed that the section of the constricting fibers was not complete. Re-incision throughout the entire length of the pylorus resulted in cure. In the other case there was apparently an incomplete division of the pyloric fibers. Symptoms had persisted and secondary operation 6 weeks later was unsuccessful the patient dying 4 days after operation following evacuation. We have been able to observe the pyloric ring in cases in which death from other causes occurred 2 months to 7 years after pyloromyotomy. In all cases an apparently normal pylorus was present.

SIGNS AND SYMPTOMS

Chart I shows the age at which hospitalization began. Sixty nine per cent were 6 weeks or younger with the peak at 4 weeks. The proportion of males to females was 84.7 per cent to 15.3 per cent.

The five major signs and symptoms were

- 1 Failure to gain in the absence of fever or other signs of infection.
- 2 Persistent vomiting of the projectile type, occurring shortly after feeding the vomitus consisting of stomach contents never bile stained.
- 3 Visible gastric peristalsis moving from left to right.
- 4 Scanty stools.
- 5 A palpable pyloric tumor.

Other signs and symptoms observed in many cases, and which confirm rather than establish the diagnosis, are (a) loss of fatty tissue, (b) dehydration, (c) ketosis (acetone breath and acetone in urine) (d) alkalosis (tendency toward hypertonicity and gastric tetany) (e) fullness of epigastrium (due to hypertrophy of stomach musculature and dilatation of the stomach), (f) flatness of hypogastrium (due to failure of food to pass through the pylorus) (g) diarrhea. In

13 per cent of the case histories, diarrhea was emphasized to a greater extent than scanty stools (frequently inaccurately referred to as constipation). The reason for the diarrhea was usually obtained from careful study of the case history. Multiple forms of cathartics and enemas had been given to cure the patient of "constipation." In addition there may be the diarrhea associated with starvation, the stools being composed of intestinal secretions.

The five major signs and symptoms have been observed prior to operation in all of the last 200 patients treated at the Children's Hospital. In only 1 case was the diagnosis not confirmed at operation.

The information from the barium meal roentgenogram shows the amount of food that passes through the pylorus and the rapidity of emptying of the stomach. It is possible to obtain this information, though not so promptly by a study of the amount of feces passed by rectum. The presence of barium in the stomach at the time of operation adds to the technical difficulties of operation. We now place less reliance on the shape of the stomach as shown by the roentgenogram in making a diagnosis than formerly. In the last 200 patients, the roentgenogram has been used in only 16 cases.

ETIOLOGY

We have no satisfactory theory as to the etiology of congenital hypertrophic stenosis of the pylorus. We found no evidence supporting the theory that injury to the central nervous system during birth may be an etiological factor. We found no suggestive association between this disease and such conditions as megalo-ureter or Hirschsprung a disease. There is no racial predisposition to this disease. Vitamine deficiency in the diet is apparently not a causative factor in this disease. We found no proof for the theory that the condition occurs more often in the first born. The occurrence of these symptoms in the first born is not in itself of especial diagnostic significance.

SUMMARY

Analysis of the 425 cases establishes the safety of surgical treatment of pyloric stenosis. Because the mortality and morbidity is greater in the age group of 6 weeks and over who have had longer duration of symptoms and treatment, we advise operation as soon as the diagnosis is established. The shorter the period of symptomatology the better is the operative risk. The safety of surgical treatment of pyloric stenosis is dependent on the close observance of many details. This includes

1 Combating and overcoming the loss of body fluids before and after operation. The measures to be used are dependent on the degree of dehydration the degree of dehydration will be greater in cases having a longer duration of symptoms.

2 Especial care in preventing loss of body heat before during and after operation

3 The greatest care in controlling hæmorrhage at operation. Rigid asepsis and painstaking approximation of the abdominal wound

4. Incision in the "bloodless" area of the pylorus being sure that all constricting fibers are divided but using especial care not to perforate the mucosa of the pylorus at the duodenal end. It is safer to use blunt dissection in completing the division and spreading of the serous and muscular coats.

5 Hæmorrhage from the pyloric incision not controlled by hot saline packs must be controlled by suture with or without using a piece of rectus muscle

6 The care during the first 4 or 5 days following operation must include the maintenance of the fluid requirements by methods supplementary to what can be administered by mouth. The caloric needs usually cannot be met for these first 4 or 5 days following operation and it is unwise to attempt to do so. If the fluid requirements 3 ounces per pound of body weight are met the caloric intake is of minor importance during this short period

7 We believe that ether by open drop method is the best and safest anæsthetic

CONCLUSION

We believe that pyloromyotomy is the treatment of choice in congenital hypertrophic stenosis of the pylorus. This surgical treatment can and should be made safe enough to warrant its use in all cases. We believe that pyloromyotomy should be advised when the diagnosis is established and that it offers safe sure prompt and lasting relief of symptoms.

EARLY DIAGNOSIS OF CARCINOMA OF THE CERVIX

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AT present there are only two valuable methods of treating carcinoma by operation and by radiation therapy. All attempts at serological, pharmacological or dietetic treatment have so far proved to be of no practical value and have resulted in failures. It is rather doubtful, therefore, whether with present facilities of investigation, better results can be expected in the near future.

Of the two practical and valuable methods, the surgical treatment, at least as far as the gynecology is concerned, seems to have reached a point where no further improvement can be expected. Any changes in operative technique made in the last few years are simply modifications of well known methods. The technique of applying radiation in carcinoma of the uterus seems almost to have reached a similar stage. It is true that in the last few years some modifications have been made but it would seem that progress can be expected only from the physicists through the invention or discovery of new tubes and rays, for the radiologist now makes the best possible use of the instruments which have been given to him by the physicist.

Early diagnosis and treatment are the only and the best means we have today of improving the results in the treatment of carcinoma. There is no doubt that early operation and the application of radiological measures before the wide extension of the cancer decidedly improves the prognosis. If the carcinoma is internal and therefore cannot be seen, early diagnosis is difficult and probably depends upon some general reaction yet to be discovered, the presence of which may be revealed by examination of the blood, urine, serum or skin. Of course if diagnosis were thus possible it would still be very difficult to find the site of the tumor. At the present moment, in spite of the high standard attained in the study of cancer we are far from reaching this goal. Somewhat more favorable are the possibilities of detecting carcinoma of the epithelium in areas readily examined with the eye as for instance the skin, mouth, penis, vagina, cervix. In any case the main thing is to be able to make diagnosis during the earliest stage. This can be done only if patient comes for consultation during this stage.

The laboratory of our clinic, following the example of Wertheim, Schottlaender and Ker-

mauer is making a most intensive study of carcinoma of the cervix and for some years we have been making extensive examinations in an effort to make a diagnosis in the early stage of carcinoma of the cervix. The first condition necessary in making such a diagnosis is to obtain data as to the appearance peculiar to the growth in the earliest stages. My first work, therefore, was devoted to discovering this information. The work was simplified by the fact that the area of predilection for carcinoma of the cervix is the region near the external os. Thus I was very likely to find data in a systematic examination of some 100 or 1000 uteri. As a matter of routine I have for several years examined under a microscope cross sections of the cervix of each uterus removed at our clinic for any reason, for example fibroids, inflammatory tumors of the adnexa, inflammation of tubes, neoplasm of ovaries, etc. I have thus succeeded in securing data as to the histological pictures presented in the early stages of the carcinoma of cervix. It must be clearly understood that these histological findings, which I can describe morphologically quite precisely, really represent the earliest stages of a carcinoma which, if not removed, would have developed into the more advanced type of carcinoma of cervix. This would be easy to prove if the early cancer were a miniature of a developed carcinoma just as a young mouse 3 weeks old is a miniature of an old one, consideration of course being given to the difference in size. The scientist as well as a person not familiar with science who has no knowledge about mice would conclude from morphological similarity that the grown up mouse develops from the young one. The evidence is more difficult if the early stages are morphologically different from the final stage. There is no morphological similarity between a 10 day old embryo of a mouse and a newborn mouse and the common sense upon which many biologists think they can rely is missing. Direct observation is not readily possible either as we cannot observe the embryo's development into a mouse. The evidence that the embryo is the first link in the development of a newborn mouse can only be secured through a series of microscopic pictures to include the whole evolution with the intermediate stages. These changes are not accessible under direct observation, but it is possible to

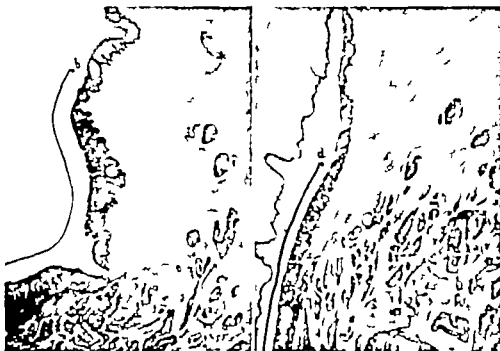


Fig 1A

Fig 1C



Fig 1B



Fig 1D

Fig 1 Case No 20237 A Advanced solid carcinoma of the squamous epithelium of the cervix with an extended border layer. At the upper border of the section the carcinomatous border passes sharply into normal epithelium. The thin line here and in the following illustrations marks the superficial extension of carcinoma. ($\times 20$) B Transition of carcinoma and normal epithelium highly magnified. ($\times 50$) C, Another marginal portion of the same carcinoma with characteristic sharp and sloping transition. ($\times 15$) D The same transition highly magnified. In the characteristic way the carcinoma appears further in the deep layers and the normal epithelium in the superficial layers. ($\times 50$)

secure a complete series of slides showing intra-uterine development. This method, the foundation of embryological research can be applied as well to the development of carcinoma. The prevailing opinion as to carcinoma is based upon a study of carcinoma in the advanced stage at which time it has become superficially ulcerated and penetrates deep into the organs, and this picture has remained with us since before microscopic research was known. The microscope

however revealed further characteristics, namely atypism and polymorphism in short the irregularity of cells. I am going to attempt to show that in the earliest stages of carcinoma the microscopic features mentioned are found instead of the older macroscopic characteristics.

For didactic reasons I shall not begin with the smallest carcinoma but with the type of carcinoma which has been diagnosed clinically for many years and has been accepted as such, in other



Fig. 2A.

Fig. 2 Case No. 186 o. A. Advanced solid carcinoma of the cervix, marginal part. Normal epithelium to both sides of the fornix. Between the carcinoma and the normal epithelium there is a small and short carcinomatous layer which is smaller than the normal epithelium and from which it is sharply separated. It forms characteristic blunt mushroom-like projections which do not grow deeply ($\times 18$) B. The short carcinomatous border layer with round epithelium projections and the sharp transition in comparison to the normal epithelium highly magnified. ($\times 57$) C. Carcinomatous epithelium from the border layer ($\times 475$) D. Carcinomatous epithelium from the downgrowth of a deeply penetrated carcinoma. The histological picture shows the absolute similarity to the carcinomatous layer in B ($\times 475$)

words, the carcinoma upon which our ideas of this growth have been founded. An examination of the region immediately surrounding a large carcinoma of the cervix reveals that in most of the cases the growth is separated from the normal epithelium by a small inflammatory zone free of

epithelium. Wherever the carcinoma penetrates from the surface into normal tissue there is present a narrow zone with inflammatory infiltrated connective tissue not covered with epithelium or with cancer. Although in a small percentage of cases the carcinoma is in direct junction with the surrounding normal epithelium (so that the normal epithelium does not project over the downgrowth) the carcinoma forms a surrounding superficial layer of about the same depth as the normal epithelium and, as I have always found, definitely marked off as though the area had been outlined with a ruler. Schottlaender and Kermauner were the first to notice the superficial narrow layer. They called it the carcinomatous superficial layer. While they mention only a few cases, in my systematic examinations I have found a great number of cases presenting these carcinomatous layers. When examining carefully I have also found that when in one spot carcinoma is marked off from normal tissue by a zone free of epithelium the growth is usually wholly surrounded by such a zone free of epithelium, and if there is a carcinomatous layer in one place the growth is always completely surrounded by such a carcinomatous layer. Obviously the kind of demarcation does not depend on local circumstances but rather on the biological nature of the carcinoma and of the organism in which carcinoma develops.

The question arises. Is this carcinomatous layer really a part of the carcinoma? On the basis of the characteristics of advanced carcinoma the answer must be in the negative, for the carcinomatous layer is neither superficially ulcerated nor does it invade the deeper tissue. Neither does it meet a further requirement: the layer is definitely marked off from the connective tissue and does not show any tendency to penetrate deeply neither by single cells nor by groups of cells. From the old and antiquated point of



Fig. 2B.



Fig. 2C.

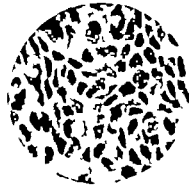


Fig. 2D.

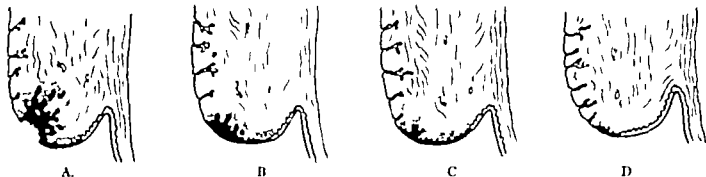


Fig. 3 Diagram of the development of a carcinoma of the squamous epithelium of the cervix. A Advanced downgrowth, superficial ulceration, carcinomatous superficial layer. B Downgrowth and superficial layer. C Beginning downgrowth and superficial layer. D Superficial

layer only which means change of superficial squamous epithelium next the external os into the carcinomatous type. The carcinoma begins to develop as shown in D and progresses as shown in C, B and A.

view carcinoma is diagnosed only when it penetrates deeply and then the carcinomatous layer is separated from the carcinoma and is considered a surrounding region, not a carcinomatous zone. From the histological point of view, however, this hypothesis is altogether wrong because the layer shows the characteristics of carcinoma atypical and polymorphic cells and frequently plenty of mitotic figures. In addition there is no histological difference whatsoever in the area where the carcinomatous zone passes into the deeply penetrating carcinoma while there is a distinct histological difference at the point where the carcinomatous layer is marked off from the epithelium. We must of necessity therefore consider the carcinomatous layer as part of the carcinoma (Figs 1-2). In my systematic examinations I have found carcinomata in which the proportions of the downgrowth and the superficial carcinomatous layer were in inverse relationship to the usual proportion in advanced carcinomata in which the downgrowth is the paramount part while the carcinomatous layer is but a small area surrounding it. The amount of downgrowth is several hundred times as great as the superficial layers in some of the smaller carcinomata; however the proportion is reversed. The carcinomatous layer is larger and in the slide frequently covers half the cervix, occasionally extending to the fornix while the deeply penetrating parts consist of but a few relatively small downgrowths showing only very shallow superficial ulceration. In the next type we find a somewhat smaller carcinomatous layer with only 2 or 3 downgrowths at the external os, yet with no ulceration. In still a younger type there is but one small short downgrowth and no superficial ulceration. In the last and youngest type are the cases which have only a carcinomatous layer and no deep penetration, downgrowth at the external os, or ulceration.

The cases presenting the very small carcinomatous layer with no deep penetration or ulceration formed part of the material for my histological examinations. A study was made of cases presenting all of the intermediate stages from the beginning penetration at the external os, the progressing downgrowth with ulceration at the external os, up to and including the large advanced carcinomata which completely infiltrate the collum and are superficially ulcerating crateriform growths (Fig. 3). If the carcinomatous area bordering the carcinoma is recognized as carcinoma and we are logically bound to accept this assumption as true then from our study of the uninterrupted series the smallest carcinomatous layers with no downgrowth must be considered as carcinoma as well. That is a picture of the youngest stage of carcinoma that we are able to recognize at the present moment. These smallest of carcinomata which include the last cases in our histological collection are 2 to 3 millimeters in diameter sections of epithelium at the external os the epithelium through changes in its cells to polymorphic and atypical types becoming characteristic of the carcinomatous layer.

In this early type there is no downgrowth or metastasis—two phases in the development of carcinoma. Downgrowth is bound to develop sometimes it appears early, but sometimes it may not appear for months and years. The same is true as to the early and late appearance of metastases. It must be emphasized however, that the presence of carcinoma is not synonymous with downgrowth—there is an early stage of carcinoma in which are present certain tissue changes characteristic of this stage of development for instance the cell changes the appearance of atypical and polymorphic cells—but the growth has not begun to penetrate the deeper tissue.



Fig. 4A.

Fig. 4. Case No. 25628. A, Commencing carcinoma of squamous epithelium at the external or not penetrating deeply yet. The carcinoma appeared over the region of healed cystic erosion. (X15) B, Carcinomatous tissue from the layer highly magnified. (X475.)

The objection that the carcinomatous layer is not carcinoma because it does not penetrate deeply is equivalent to saying that the embryo of a mouse has not the characteristic features of a mouse because the embryo does not breathe through its lungs as a grownup mouse does. Breathing through the lungs is a postnatal characteristic of the mouse while the properties of a mouse are inherent in the embryo.

The term "precancerous" for carcinomatous layers seems to carry two different meanings: some authors use the term "precancerous" to designate a growth which may become carcinoma while others use the term in reference to a growth which is bound to become carcinoma. As long as the term "precancerous" has more than one meaning it should be avoided. The study of our uninterrupted series would indicate that a carcinomatous layer may represent two things: either the borderline of an advanced carcinoma—in which case it is senseless to call it anything

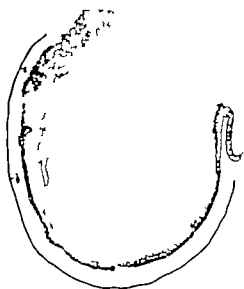


Fig. 5A.

Fig. 5. Case No. 7796. A, Commencing carcinoma consisting of an extended superficial layer which has penetrated deeply in one place only. The deepest part lies $1\frac{1}{4}$ millimeters from the surface. (X5) B, Carcinomatous layer highly magnified. (X67) C, The region of deep penetration highly magnified. (X90.)

else but cancerous—or the early stage of carcinoma which later on will penetrate deeply. In this case too it is better to use the term of "young carcinoma" or early stage of carcinoma, instead of the ambiguous term "precancerous." Our experience has demonstrated that the smallest carcinomatous layer without downgrowth will later if allowed to grow develop into a deeply penetrating carcinoma and eventually ulcerate superficially. We do not speak of a "prehuman embryo" but of a "human" embryo and I believe the same thing applies to cancer: there is a "carcinomatous layer" but not a "precancerous layer."



Fig. 4B.

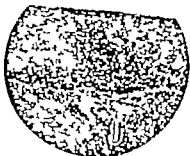


Fig. 5B.



Fig. 5C.



Fig 6A



Fig 6B



Fig 6C

Fig 6 Case No. 1904. A Early commencing carcinoma of the cervix consisting of a larger superficial layer and two small projections in the region of the external os. The section shows the characteristic carcinomatous superficial layer and its separation from the normal epithelium

to the right. ($\times 20$.) B Two small projections dip deeply into the region of the external os with strong inflammatory infiltration of the surrounding tissue ($\times 40$.) C Tissue from the carcinomatous layer highly magnified. Atypical mitotic figures, atypical nuclei ($\times 45$.)

The histological characteristic of this carcinomatous layer has already been mentioned polymorphic and atypical cells especially as regards the nuclei. Large nuclei may be surrounded by small ones dark nuclei may be next to light nuclei and occasionally giant cells may be found with several nuclei in one cell. The great number of nuclei is extraordinary there being more nuclei than in the healthy epithelium. The regular order as seen in normal epithelium is absent. In healthy epithelium the number of nuclei diminishes centrifugally from basal layer to the surface, until in the superficial layers only a few shrunken nuclei living in large cell alveoli are found. In the presence of a carcinomatous layer however we find on the surface a great number of dark nuclei lying close to one another. The basal layer is sharply demarcated against the under

lying connective tissue and never shows projecting single cells or groups of cells. This is no counterevidence against the carcinomatous character of the epithelium. In advanced carcinoma of great maturity the projections in the depth of tissue with sharply defined basal cell layer are regularly seen (Fig 7). The division and separation into basal layer prickly-cell layer superficial vesicular parakeratotic layer are abolished. Occasionally however we can still find remnants of the former epithelial differentiation in carcinomatous epithelium. Just as there are hornifying carcinoma of the skin and the ability of the normal skin to become horny is still preserved and just as there are carcinomata of the mucous membrane and the function of the normal gland is preserved (the pathologist calls them carcinomata of very advanced maturity or of great dif



Fig 7A



Fig 7B



Fig 8

Fig 7 Case No. 2790. A Projection from a hornified carcinoma of the cervix of high maturity ($\times 40$.)

B A projection in high magnification with distinctly demarcated basal layer ($\times 40$.)

Fig 8 Case No. 27484. Normal vacuolized epithelium containing glycogen, from a scraping ($\times 57$.)



Fig. 9A

Fig. 9 Case No. 37037. A, Commencing carcinoma of the squamous epithelium of the cervix which led to an inoperable recurrence in spite of a hysterectomy. The carcinoma consists of a small superficial layer with only little downgrowth along the cervical glands in the cervical canal. In spite of an operation the tumor reappeared and was inoperable. ($\times 5$) B, Transition in respect to normal epithelium, highly magnified. ($\times 57$) C, The carcinomatous layer highly magnified. ($\times 15$) D, Beginning of the deep penetration along the cervical glands, highly magnified. ($\times 60$.)

ferentiation) there are also carcinomatous layers still showing a distinct basal or parakeratotic layers on the surface, certain rests of differentiation. Such remnants of potency of differentiation do not contra indicate the carcinomatous nature of the layer. The demarcation between the carcinomatous layer and the normal epithelium is always distinct, so that it is possible to indicate the exact point to which the carcinoma reaches and where the normal tissue commences. Areas of transition are nowhere to be found, nor are there transitory cells in contradiction to this fact are the hornifying carcinomata of the vulva and

of the skin in which there is no distinct demarcation between carcinomatous and normal tissue, obviously on account of the great maturity of tissue. Occasionally we can see within the normal tissue near the borderline single dark cells which, from a morphological standpoint, are characteristic of carcinomata. The line of demarcation is always oblique and always proceeds so that, in the basal part of the growth, it reaches farther than the normal epithelium does on the surface, i.e. the carcinomatous layer is wider at the base than on the surface. A further characteristic of carcinomatous epithelium is that the superficial layer which in normal epithelium consists of large vesicular light cells with small shrunken nuclei or rests of nuclei is missing. This superficial layer which is typical in the epithelium of the cervix—normally the epithelium of the cervix does not show parakeratosis—is filled with glycogen as proved by staining (Fig. 8). As Schaffer pointed out the squamous epithelium undergoing differentiation may be transformed into horn or it may gather glycogen. In the epithelium of the cervix the latter property is characteristic, and the glycogen disappears when the epithelium becomes a carcinomatous layer. This is true not only for the superficial layer of the epithelium of the cervix downgrowths and extension of epithelium too are free of glycogen. This glycogen is not soluble in water. It is called glycogen of the epithelium and should not be mistaken for the glycogen of the liver and muscles which glycogen is soluble in water. The insoluble glycogen of the epithelium can be stained according to Best on slides which have been washed in running water for hours. Occasionally soluble glycogen is found in carcinomata of the collum characterized histologically by large light vesicular cells. Laemm, Babes and Lazarescu-Pantzu have described such cases, which are rare and in which the glycogen is very different from the cervical epithelial glycogen.



Fig. 9B.



Fig. 9C.



Fig. 9D

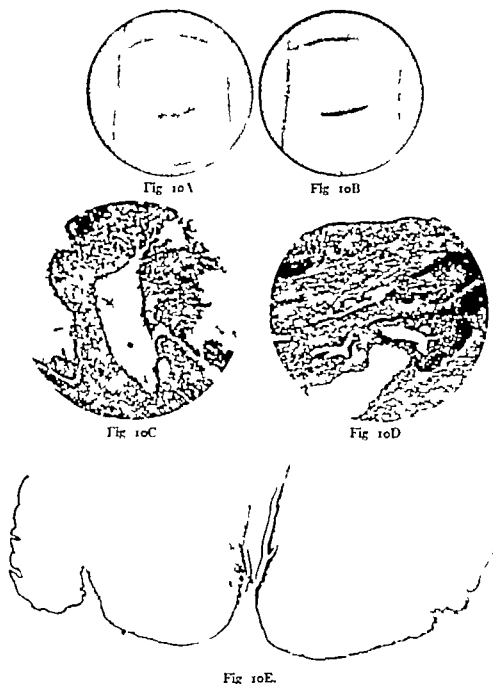


Fig 10E.

Fig. 10. Case No 27573. A Cervix as it is seen through a speculum. B After painting with Lugol's solution. The normal epithelium was stained a dark mahogany brown color around the erosion an unstained uneven zone was seen which after hysterectomy and histological examination proved to be carcinoma. C, Scraping showed Carcinomatous polymorphic epithelium. ($\times 57$) D Beginning downgrowth inside of cervical canal. ($\times 60$.) E Section through the cervix. In consequence of shrinkage caused by fixation in formalin the carcinoma appears retracted in the cervical canal. ($\times 0.8$.)

A further evidence that the carcinomatous layers are actually carcinomata is to be seen in similar diagnoses in the skin. To Bowen belongs the credit of discovering and describing such findings in relation to the skin. He was the first to notice the changes in the epithelium which are characterized by polymorphic and atypical cells, great numbers of cells and nuclei, and the clump-

ing cells without downgrowth. Because he found no downgrowths Bowen described the cases as being specific precancerous and so the condition became known as Bowen's precancerous dermatosis. Subsequent controls confirmed Bowen's diagnoses. After prolonged observation, however, Bowen found that downgrowth began to develop, i.e. the dermatosis became a true carcinoma of



Fig. 11A.



Fig. 11B



Fig. 11C.

Fig. Case No. 27-03. A, Scraping of the iodine negative area. A typical polymorphic epithelium with downgrowing projection which was diagnosed as carcinoma ($\times 67$). B, A beginning carcinoma of squamous epithelium at the external os. On the left is shown the inflammatory infiltration of the cervical tissue on the

right in the upper corner of the section a carcinomatous layer with a sharply defined demarcation. Two superficially placed projections are seen below the sharp border. The larger one has a triangular form with a space in the center ($\times 15$). C, The transition strongly irregularized. ($\times 57$)

the skin. This transition took place after a few months in some cases after a few years, so that the hypothesis was accepted that Bowen's dermatosis was only a special form of carcinoma of the skin different from the other forms only in the extraordinarily long interval between development on the surface and in the deeper tissue, it was the Dutch dermatologist Caroll who laid down that idea most precisely. Bowen's dermatosis, that is, the form of carcinoma of the skin discovered by Bowen, commences its growth as a superficial layer but does not affect the deeper tissues. It refutes, too, as do our diagnoses as to the cervix Ribbert's theory that carcinoma originating from epithelium misplaced in the deep initiates in the deep. Histologically and cytologically Bowen's dermatosis corresponds with our diagnoses of the cervix.

A further evidence that these smallest carcinomata really are carcinomata is to be found in the fortunately rare clinical failures. A report of a characteristic case of this kind follows.

A woman aged 46 years, was operated upon on account of tumors of the adnexa, and a hysterectomy was done. The cervix seemed quite smooth, showed no suspicion of cancer and macroscopic examination showed no erosion. I must add that this patient was examined and operated on in 1937 at which time we had formulated no special method for the early diagnosis of carcinoma of the cervix and had not attained sufficient experience to determine the histological aspect of the early stages. After systematic examination of the cervix a typical polymorphic celled, carcinomatous layer was discovered, with distinct demarcation and free from glycogen. Within the cervical canal two small areas were noted in which the growth had begun to penetrate the deeper tissue. The wound healed by first intention and the patient was discharged from the hospital after she had been given a short course of treatment for

slight bladder trouble. She was free from complications for a long time, but after 4 years she returned to our clinic with the typical neuralgic pains in both legs and a carcinoma, almost the size of a fist, located in the small pelvis which could be easily palpated. In spite of total extirpation there probably was already formed a very small metastatic growth which caused the reappearance. Had we been able to diagnose carcinoma with certainty 4 years previously, the parametria would have been removed as well by Wertheim's method and the patient would have been given strong radiation after treatment.

This case is strong evidence of the necessity for recognizing that the carcinomatous layer is carcinoma in an early stage. With our knowledge today of the appearance of an early stage carcinoma such a catastrophe could not occur (Fig. 9).

After we had succeeded in determining to our satisfaction what the appearance of earliest stages of carcinoma were like the question naturally arose as to how the earliest stages could be recognized clinically. By most careful comparison of the appearance of the macroscopic operative specimens with the appearance through the speculum it was found that to the naked eye these smallest carcinomata resembled small, white opaque, dull sometimes also slightly wrinkled, spots in the smooth white transparent epithelium of the cervix. That is exactly what has been described years ago by the French and English authors as "leucoplakia" and to which in more recent years Franqu² and his pupil Hinselmann were the first to draw our attention. By comparing histologically numerous specimens of leucoplakia I was able to state that the great majority were carcinomatous layers but that there were instances in which while the patches appeared in the speculum examination as typical



Fig. 12

Fig. 12. Case No. 24156. Scraping. Real hyperkeratotic leucoplakia in prolapse. ($\times 6$)

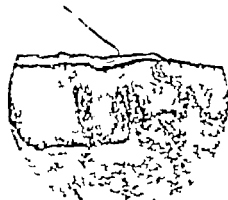


Fig. 13

Fig. 13. Case No. 24155. Typical leukoplakia with real hyperkeratosis. ($\times 60$)



Fig. 14

Fig. 14. Case No. 27318. Hyperkeratotic leucoplakia in leukemia.

leucoplakia yet histologically they were only areas of hyperkeratosis. Such hyperkeratotic areas may originate either in the presence of prolapse when the epithelium is exposed to the drying influence of the air or in the presence of secondary syphilis. With the naked eye it is not possible to differentiate between carcinomatous leucoplakia and hyperkeratotic leucoplakia. With Hinselmann's colposcope by which the field can be strongly magnified and with which it is possible to examine the cervix precisely several interesting morphological details regarding leucoplasias may be discovered but the instrument does not make it possible to distinguish with certainty between carcinomatous leucoplakia and hyperkeratotic leucoplakia. This differentiation can be made only by histological examination.

The clinical diagnosis of leucoplakia is sometimes made difficult because the affected area is so small that it cannot be easily seen with the naked eye. The colposcope however often shows such areas more distinctly but as the colposcopic field of vision is relatively small it is therefore necessary to examine carefully the whole cervix from the external os to the fornix in order to find such leucoplakic areas. An examination of this kind requires skill and time. In a crowded out patient department it is hardly possible to examine a cervix for such minute detail and it is no doubt true that often cervixes which appear to the naked eye as healthy smooth and un-suspicious, really harbor small incipient carcinomata.

Some method had to be found to locate the suspicious spots more easily and quickly. I discovered this method—vital staining with Lugol's solution. A startling revelation was made—the fact mentioned that normal epithelium of the

cervix contains in its superficial layers glycogen yet no carcinomatous epithelium. This glycogen may be stained on the slide with Best's carmine and on the living patient with iodine potassium iodide solution. When the normal cervix is painted with ordinary Lugol's solution (iodine 1 potassium iodide 2 water 300) the epithelium acquires in about half to one minute a mahogany brown color. However in the areas in which some pathological process is present no brown staining takes place and the epithelium remains white and unstained. Thus diseased spots in the epithelium which escape the naked eye altogether and which can be found only by systematic and painstaking examination of the cervix with the colposcope are made visible in about a minute's time (Fig. 10). The technique used in painting the cervix is as follows. A cervical speculum is placed in the vagina and out of a small cup with a long spout about 10 to 15 cubic centimeters of Lugol's solution is poured and spread with a tampon over the cervix and left in the vagina for about a minute. The iodine solution is then sucked off with a tampon the cervix and vagina are cleaned of the excess liquid and gently wiped. It is very necessary that the solution should moisten the entire cervix and that no fold should prevent the entrance of the liquid as that might cause wrong diagnoses. If the epithelium shows an unstained spot we must be suspicious of cancer and the tissue here must be examined histologically. As a rule the presence of white, unstained epithelial spots which are free from glycogen may indicate four possibilities:

1. The presence of carcinomatous layers or incipient carcinomata (Fig. 11)
2. The presence of hyperkeratosis a result of prolapse or descensus vaginae (Fig. 12)

3 The presence of hyperkeratosis, a consequence of luetic infection (Fig. 13)

4. The desquamation of the upper layers of glycogenous epithelium which may have been caused by the touching of the cervix with sharp instruments or by the rough insertion of the speculum. Such traumatic desquamations are easily to be diagnosed by their form as they resemble narrow sharp and straight line scratches.¹

The decision as to the group in the terminology mentioned in which the unstained spots of the epithelium belong can be made with certainty only by microscopical examination. Colposcopic examination alone does not give sufficient evidence in all cases. To obtain material for the histological examination we do not use the V shaped exploratory excision because the changes concern only the superficial epithelium and there is no need to make an excision into the deeper tissues. It is sufficient to scrape off a small piece of epithelium with a small spoon often we may loosen the epithelium with the spoon and with a tissue forceps pull off a thin film. The advantage of this method is that it is necessary neither to proceed surgically nor to suture the wound made by excision. In our experience skillfully removed pieces of epithelium are completely replaced by nature in 2 or 3 days and evidence of removal cannot be found.

Painting with iodine is of value in locating the new growth as long as it is in the stage of a carcinomatous layer. As soon as the growth ulcerates, the surface nearly always being necrotic stains brown with iodine and the method is therefore not helpful. On the other hand, ulcerated carcinomata are generally larger and more extensive and are therefore easily visible. In addition they are surrounded eventually by a line of demarcation of carcinomatous epithelium—a white superficial stripe around the ulceration. When a scraping is removed for diagnosis the white stripe should be scratched off and not the ulcerated part or the normal brown epithelium. The simple erosion is covered on the surface with inflamed connective tissue but later, during the first stage of healing is covered with cylindrical epithelium. In both instances the erosion to the naked eye has a more or less dark red, dull velvety color. It becomes only slightly stained with iodine solution. It cannot be mistaken for the white superficial carcinomatous layers. The tissue for diagnosis as already mentioned, should be taken from the white layers but never from within the dark red, eroded or ulcerated parts.

¹ A few months ago we found hyperkeratosis leucoplakia in a case of leukorrhea, which is a very rare incidence of coincidence (Fig. 14).

In our clinic we use the same method to determine the extent of farther advanced carcinomata. It has been found that advanced carcinomata are surrounded by carcinomatous layers, the width of a finger which are totally invisible to the naked eye. If when removing the carcinoma within the carcinomatous layer the operator fails to remove completely the carcinomatous layer itself a recurrence is inevitable. I examined the postoperative specimens of a series of carcinomata apparently radically operated upon but which in spite of radical extirpation had reappeared. It was apparent that these carcinomata were surrounded by carcinomatous layers the greatest part of which had not been removed. This mistake can be avoided if the region of the carcinoma is painted with Lugol's solution before the operation and if the operator observes strictly the limits of stained tissue, so that he removes all growth within the brown zone but by no means within the white carcinomatous area.

A further advantage of this method is that it is easy and does not require expensive instruments. In fact, no special instruments are needed and no special ability or technical training is required. It is not troublesome for the doctor or painful for the patient. Furthermore Lugol's solution is not expensive and the examination takes only 2 to 3 minutes—specular examination is prolonged by 2 or 3 minutes. It makes possible the diagnosis of a carcinoma of the cervix in its very first stage—a factor of much importance in securing absolute healing.

The histological diagnosis is made from the characteristic polymorphic and atypical cells of the epithelium. Up to the present time we have not known of a characteristic of carcinoma which would enable us unmistakably to diagnose it. We cannot be more exact in our definition of polymorphic and atypical tissue the ability to recognize it is merely a matter of training and experience as are many other things in medicine. In medicine many diagnoses are made which cannot be supported by measurements, figures, or by an objective criterion as the evidence of parasites. The internist diagnoses pneumonia because he finds dullness on percussion of the chest but he does not attempt to measure or try to represent the pneumonia in an objective form. He is able to diagnose it because of his medical experience and knowledge. Just as the experienced internist diagnoses pneumonia so we are able through experience and study to diagnose a carcinoma. Anyone who has seen a large number of cases of early carcinoma will have no difficulty in diagnosing the condition. Experience in a number of

cases is the important factor in gaining knowledge—after the diagnosis has been made in 10 cases less difficulty will be experienced with the eleventh and succeeding cases.

I consider the knowledge gained from accumulated clinical experience of great importance. We have kept on file in our clinic each histological specimen, whether positive or negative and have kept in touch with each patient. As a result we have in our histological museum many hundreds of slides on which the diagnoses are insured and have been proved by clinical after-examinations and controls.

When an incipient carcinoma of the cervix is revealed by our method of painting with iodine we proceed at once to operate. In our clinic radiation is not used as a routine treatment in operable cases. If the patient is an elderly woman near or past the climacteric we prefer to do a panhysterectomy rather than to use any other method. Only in young women who have tiny incipient carcinomata do we eventually use the method of amputation of the cervix and we try to remove as much as possible of the cervical canal. The amputated cervix is cut in serial sections which are carefully examined to define the extension of the carcinomatous layer. If the examination shows that the removal was done at one place inside the carcinomatous layer i.e. that the carcinoma was not completely and radically removed, then we proceed to extirpate the uterus and remove at the same time a part of the vagina. We do not consider it wise to do a mere excision of the carcinoma for the following reason: incipient carcinomata frequently extend high up into the cervical canal—even when the superficial examination shows outside the external os only a small carcinomatous area of a few millimeters in length and breadth the histological examination may reveal deeper high up in the cervical canal a continuation of the typical carcinomatous epithelium. Mere excision therefore does not remove these parts and the reappearance of the tumor would most certainly follow.

Of course we cannot expect from a method more than it is worth. All circumstances considered some methods have been criticized because of failures when in reality the method was not applicable and good results could not be expected from its use. Iodine painting is a diagnostic method only in the sense that it draws attention to the pathological area; it does not, however, indicate the nature of the pathological process. The pathological diagnosis can be made only upon histological examination. It is true that the experienced surgeon will frequently be able to

distinguish from the shape and the borderline of the white spots whether it is a case of carcinoma or only of hyperkeratosis. Painting with iodine proves only that the epithelium of the cervix is normal everywhere where it takes on the brown color; it does not prove that below the epithelium no carcinoma may be present. A carcinoma which begins in the cervical canal infiltrates the connective tissue and undermines the epithelium without reaching the surface cannot be diagnosed with the method of painting with iodine. As a general rule the deep seated carcinoma is extraordinarily rare, according to our experience the majority of cancers begin at the external os or outside close to the external os. It is true also that carcinomata which fill up the cervical canal and infiltrate the cervix completely almost always have small superficial proliferations which cover the surface outside the external os and when these are painted with iodine the presence of carcinoma is revealed. A very interesting case of this sort has been described by Preissecker.

A patient, 42 years of age had a hazelnut sized carcinoma of the cervical canal. The carcinoma extruded in a tongue shaped proliferation of hardly 2 millimeters in length from the external os. The remaining part of the carcinomatous tissue was hidden in the cervical canal and in the wall of the cervix. Through the small proliferation the carcinoma was discovered with the help of iodine painting and colposcopic examination and the patient was urged to have an operation.

In case there is suspicion that a patient has carcinoma and the iodine painting test has proved to be negative the carcinoma must be searched for in the subjacent parts of tissue by curettage of the cervical canal or by an excision of cervical mucous membrane of the external os. It would be altogether wrong to dismiss the patient without thorough examination. The diagnosis is made easier if the distinct demarcation is visible in the scraping as will be found occasionally. It is recommended that the scraped off epithelium be submitted to glycogen staining according to the Best method. The presence of large, typical vesicular, superficial layers of cells with an abundance of glycogen is positive evidence against carcinoma.

Several years ago the examination of the cervix by iodine painting was introduced in our clinic in the last 2½ years it has been used systematically. During this time 553 scrapings were made of which 140 were positive. Of course, there are among the positive cases a great number of scrapings from advanced carcinomata to verify the diagnosis and to verify the presence of the line of demarcation between the normal and the

carcinomatous layer. Forty-five patients with carcinomata were operated upon after positive diagnoses were made from scrapings. The total number of carcinoma operations during the same period of time was 90, and 19 of these were early carcinomata and operation was done upon the strength of the positive findings from examination of the scrapings. Six incipient carcinomata were found after routine histological examinations of tissue from patients who had been operated upon for other reasons e.g. fibroids and other conditions. Of these 6 cases, not a single one had been examined by the iodine painting method or from the scrapings. For this reason they should not be included among failures of the iodine painting method. Our method is not used in certain cases, for instance in those in which the cervix does not reveal a suspicion of cancer by speculum examination and the patient has been slated for total hysterectomy the next morning. In such cases, if a carcinoma should be found later the necessary treatment of hysterectomy has already been performed.

Errors may creep in but it is a fact that the number of cases in which minute carcinomata are not discovered has become smaller. 4 years ago they were 3 per cent while today they are only 6 in 425 cases of hysterectomy that is 1.41 per cent. In the 19 cases in which an early diagnosis was made and the patients operated upon clinical examinations revealed no suspicion of cancer. It is remarkable that of these 19 women 8 that is 42 per cent, were less than 40 years of age. On the basis of the fact that with early diagnosis and immediate operation in minute, beginning carcinomata we have raised the percentage of complete cures to 90 or 95 per cent. I believe that it will be possible essentially to improve results in general in regard to carcinoma of the cervix. The method of iodine painting is easy and cheap a

doctor could examine 12 to 15 women with ease in an hour's time, or in a forenoon 5 hours, 75 women. It should be considered a matter of course and it should be our duty to examine for incipient carcinoma each patient coming to us for treatment. It is a fact that in early carcinomata there is no subjective symptom which would force a woman to interview her doctor but we have found through our own experience that if patients are forced to see us because of other troubles, such as fibroids, affection of the tubes, discharge etc. it is only through routine and thorough examination that the cancer is incidentally discovered. We still have today patients who interview the practitioner and seek treatment at hospitals because of some gynecological condition and who upon examination are found to be harboring an early carcinoma of the reproductive organs. This condition could be remedied if every woman would have systematically twice or three times a year a routine Lugol's test. It would then be possible to locate a carcinoma of the cervix in its earliest stages and treatment could immediately be instituted that would raise the percentage of complete healing to 95 or 100 per cent, especially with the improvement of postoperative X-ray treatment. Such a routine examination would not involve great expense and would not require especially instructed men.

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SKIIFTAI TRACTION WITH STEINMANN PIN

RESULTS OBTAINED IN FIFTY TWO CASES OF FRACTURE OF BOTH BONES OF THE LEG¹

MERRILL K. LINDSAY, M.D., F.A.C.S., and RAYMOND M. McKLOWN, M.D., NEW HAVEN, CONNECTICUT

FRACTURES of both bones of the leg in its lower two thirds are observed with greater frequency as traffic accidents increase and although the difficulties involved in the treatment of these cases have been met with varying degrees of success, still they remain a problem requiring careful attention to detail in their management. For the past 5 years, Steinmann pin skeletal traction, followed by suitable plaster splints, has been used in this clinic in the treatment of compound and comminuted fractures of the distal portion of both tibia and fibula with very satisfactory results. It is our purpose to report 39 cases so treated with a brief consideration of the method itself and the results obtained.

Dyck states that the Steinmann pin should not be credited to Steinmann but rather to the hooks that Malgaigne used. Steinmann is believed to have used these prior to his use of a pin while Heincke later added the blades and handles. Up to the present time there can be no doubt that the pin has been used with reluctance and that still there exists a widespread belief that the procedure is not without considerable danger. Farr for one states that skeletal traction possesses inherent danger and that necrosis and infection are to be guarded against especially. Estes is of the opinion that plating is to be preferred to skeletal traction until such time as additional statistics show skeletal traction to be of more value than he thinks. In support of his contention he quotes from Sherman, Wagner, Auvray and Elinson. Hitzrot says that pin skeletal traction no doubt has its proper place but that he prefers to use open operative reduction in the treatment of fractures of both bones of the leg while Wilson on the contrary differs from Hitzrot in that he believes skeletal traction in fractures of this type to be preferable to open operation. In addition Wilson recognizes a well established fact that skin traction is usually out of the question due to insufficient skin surface available. Scudder in his paper on the treatment of recent fractures of the long bones by operation, would try in all doubtful cases the non-operative method first and holds that the honest use of skeletal traction will diminish the number of cases in which primary operation is required. From the difference of opinion available and the results seen in cases of

fractures of both bones of the leg not treated with skeletal traction we can agree readily with the statement attributed to Sir Robert Jones that

If I were asked which fracture was the most difficult to reduce in the lower limb I should say fracture of the tibia and fibula in the lower third.

From January 1927 to September 1931 we have treated 52 cases of fracture of both bones of the leg with Steinmann pin skeletal traction of which we have satisfactory records of 39 (Table I).

TABLE I—FIFTY TWO CASES OF FRACTURE OF BOTH BONES OF THE LEG

1 to 39	Reported in detail in this paper, one case (No. 33-34) having fracture of both bones of both legs.
40	Record incomplete union, however apparently satisfactory.
41	Record incomplete union, however apparently satisfactory.
42	Record incomplete union, however apparently satisfactory.
43	Record incomplete union, however apparently satisfactory.
44	Record incomplete case transferred elsewhere and roentgenograms not completed.
45	Record incomplete unable to follow up patient after discharge.
46	Record incomplete unable to follow up patient after discharge.
47	Record incomplete: roentgenograms incomplete.
48	Record incomplete discharged against advice.
49	Record incomplete roentgenograms incomplete.
50	Record incomplete roentgenograms incomplete.
51	Record incomplete, roentgenograms incomplete.
52	Gas gangrene developed at fracture wound and mid thigh amputation carried out.

In no case have we had either perceptible necrosis or osteomyelitis of the calcaneus through which the pin was inserted while in all of the 39 cases we are reporting in detail at this time we have obtained satisfactory alignment without appreciable shortening. Functional union particularly has been satisfactory throughout. The procedure is not difficult, and with the usual hospital equipment, it is undertaken with ease if a few simple principles are observed. A brief description of our technique is desirable to facilitate a more thorough interpretation of our results.

PROCEDURE

The point of introduction of the Steinmann pin into and through, the calcaneus is of fundamental importance. The blood vessels and tendons about

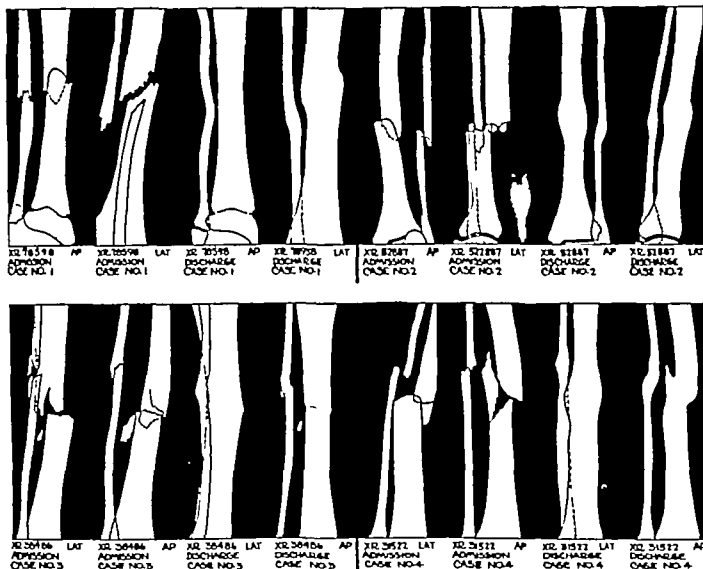
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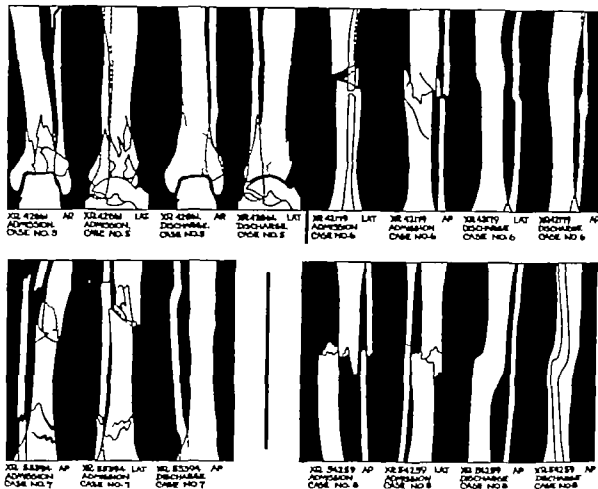


Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anesthesia	Time in pin	Time in boot	Time in Deltet	Comments
1	78598	28 ♂	Auto accident	Complete oblique comminuted tibia and fibula both compound	1 hr.	Good	General ethylene	4 wks.	7 wks.	4 wks.	Wound healed slowly. Otherwise convalescence uneventful. End-result good.
2	88370	27 ♀	Auto accident	Complete transverse tibia and fibula both compound	1 hrs.	Fair	General ethylene	6 wks.	8 wks.	4 wks.	Wound healed well, but callus slow in forming. Eventual end-result good.
3	65334	37 ♂	Auto accident	Transverse comminuted tibia and fibula	4 hrs.	Fair	General ether	8 wks.	None	Deltet with steel rod support	Fibula spontaneously consolidated 3rd day. Daily dressings. Good union by 16th week. Left at that time against advice.
4	8876	41 ♂	Auto accident	Transverse fibula. Oblique comminuted tibia	3½ hrs. at home previously	Very poor	General ethylene	6 wks.	8 wks.	None used	Walking calipers for 10 wks. Good functional result.

PLATE I

fastened to the end of a Thomas splint (Fig. 1). The skin at its two points of contact with the pin was protected with sterile alcohol dressings. After

the patient was returned to bed, traction of from 10 to 20 pounds as the case necessitated, was applied with the leg in the supporting Thomas

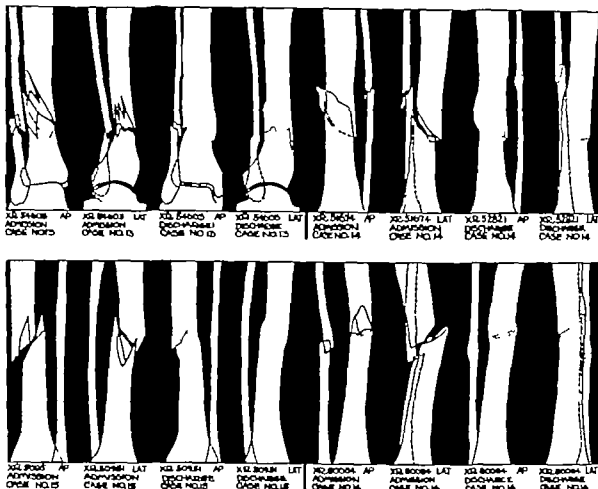


Case No.	Hemo No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operative	Anaesthesia	Time in pin	Time in boot	Time in Deltoid	Comments
5	7043	48 M	Fall from ladder	Impacted comminuted of tibia and oblique of fibula	3 hrs.	Fair	General ethylene	7 wks.	4 wks.	None used	Good end-results
6	70375	40 M	Auto accident	Complete transverse of tibia and fibula	16 days at home in full length plaster boot	Good	General gas and oxygen	3 wks.	4 wks.	3 wks.	Satisfactory
7	84437	48 M	Auto accident	Complete transverse comminuted lower end tibia and fibula	hrs.	Fair	General ethylene	4 wks.	4 wks.	4 wks.	Good. (Final lateral X-ray damaged)
8	83783	37 M	Auto accident	Complete transverse comminuted tibia and fibula	3 hrs.	Fair	General gas and oxygen	3 wks.	3 wks.	4 wks.	Good. Daily dressings to deltoid. Weakly thereafter

PLATE II

splint in balanced suspension, from a Balkan frame. The foot of the bed was elevated about 12 inches to produce counter traction (Fig 3). After 24 hours the position of the fragments was checked by roentgenograms to ascertain the suc-

cess of the procedure, as well as the amount of weight required for future traction. Angulation was corrected readily throughout this stage by changing the supporting slings, or by using the pin as a lever as suggested by Dyras and others.

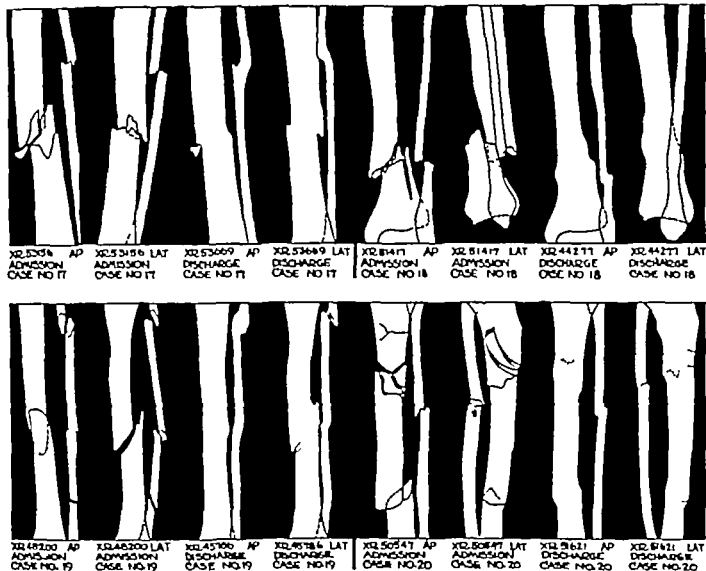


Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anesthesia	Time in pos.	Time in heat	Time in Delbet	Comments
13	20074	34 ♂	Auto accident	Complete oblique comminuted tibia and fibula	hrs.	Poor	General gas and oxygen	3 wks.	7 wks.	6 wks.	Developed diabetes. Treated by insulin. Calves not well formed until third mo. History of syphilis. End-result good
14	22104	41 ♂	Auto accident	Comminuted comminuted	hrs.	Good	Local novocaine 2%	3 wks.	5 wks.	3 wks.	Very satisfactory end-result
15	22465	18 ♂	Auto accident	Spiral oblique (Dist. Transverse fibula) (fibular fracture in upper 1/4) sustained by motorist	hrs.	Good	General ethylene	3 wks.	4 wks.	3 wks.	Good end-result
16	22004	17 ♂	Fall off ladder	Comminuted oblique fracture of tibia and fibula	3 hrs.	Good	General ethylene	3 wks.	4 wks.	3 wks.	Good end-result

PLATE IV

dent flexion at the knee to prevent rotation of the leg (Fig 3). The patient was permitted to go about in a wheel chair for 3 or 4 weeks, at which

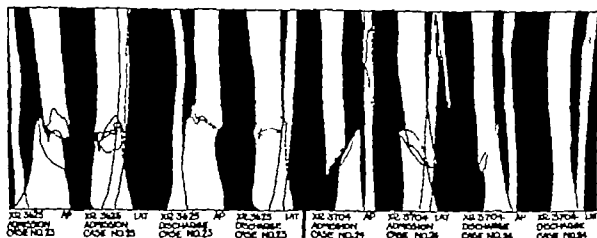
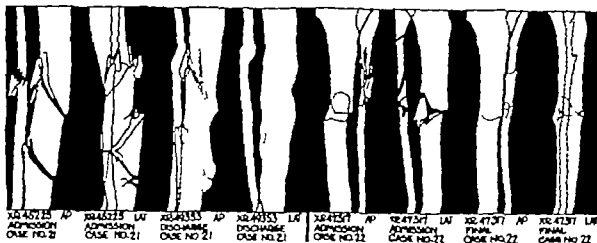
time a Delbet splint was substituted (Fig 4) and active motion of the knee and ankle was started. After painless motion in these joints had been



Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anaesthesia	Time in plaster	Time in boot	Time in Deltoid	Comments
17	82300	34 ♂	Auto accident	Oblique comminuted tibia. Transverse fibula	3 hrs.	Good	Local novocain 1%	4 wks.	3 wks.	None used	Good end-results
18	77576	37 ♂	Fell beneath moving motor cycle	Compound comminuted tibia. Oblique fibula	4 hrs.	Good	General gas and oxygen	6 wks.	5 wks.	None used	In walking caliper that wound might be dressed. Good end-results
19	72403	26	Auto accident	Spiral of tibia. 3 fractures of fibula. An upper oblique, middle oblique, and lower oblique	3 hrs.	Good	General ethylene	3 wks.	5 wks.	3 wks.	Eventually (by 4th month) good end-results. Had massive collapse of right lung for 7 days. Without sequelae
20	81447	63 ♂	Auto accident	3 fractures of tibia, upper fissured, middle transverse comminuted, lower oblique. Oblique fibula	20 hrs.	Poor	General gas and oxygen	4 wks.	5 wks.	4 wks.	Good end-result

PLATE V

accomplished, the patient was encouraged to walk in a 'walker' or on crutches, and swelling of the foot and leg, while walking, was prevented by bandaging the leg from toes to the knee with



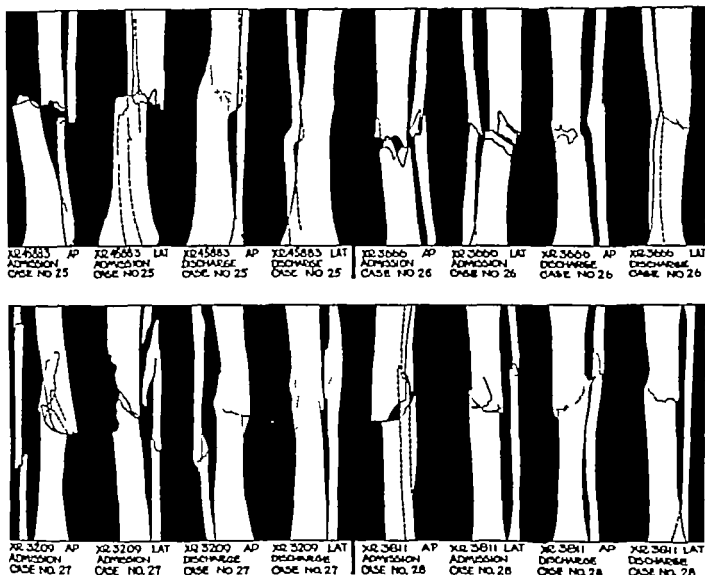
Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before last examination	Co-operation	Anesthesia	Time in pre	Time in post	Time in Delfbet	Comments
21	70994	36 F	Auto accident	apical comminuted fracture of tibia. One oblique comminuted of fibula	48 hrs.	Poor	Local novocain 1%	7 wks.	6 wks.	4 wks.	Delicious treatment as indicated. Controlled by sedatives. End results good
22	40436	36 F	Auto accident	Compound comminuted oblique of tibia and fibula	30 hrs.	Poor	General ethylene	4 wks.	3 wks.	4 wks.	Buffy checked on admission. Railed rapidly. End results functionally good
23	44490	41 F	Auto accident	Compound comminuted oblique of tibia. Questionable type of upper fibula does not show in place	hrs.	Good	General gas and oxygen	4 wks.	3 wks.	5 wks.	Also x-rayed. Absence of shock. R. end healed well under daily dressing. End result good
24	44490	46 F	Fell off dock	Oblique of tibia. Comminuted oblique of fibula	hrs.	Fair	General ethylene	3 wks.	4 wks.	3 wks.	End results good. Culture negative show in dressing

PLATE VI

an elastic bandage. The Delfbet splint was removed when the roentgenograms showed abundant firm callus.

RESULTS

Our results with this procedure in 30 cases of fracture of both bones of the leg, associated with

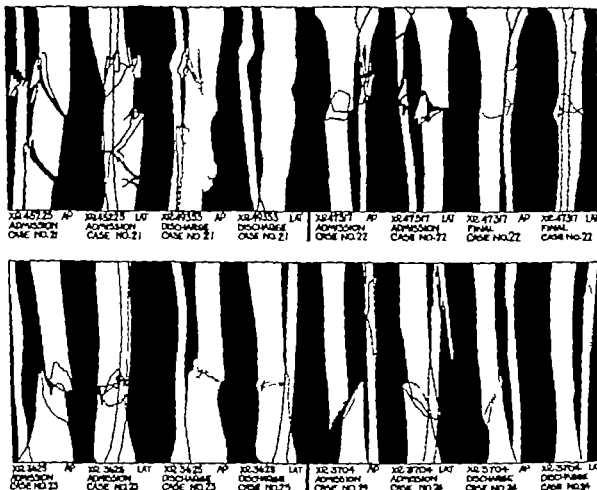


Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anesthesia	Time in pla	Time in boot	Time in Delbet	Comments
25	528	16 F	Sliding accident	Transverse compound tibia and fibula	20 hrs.	Fair	General ethylene	4 wks.	5 wks.	3 wks.	End-results good
26	79 84	19 M	Motor cycle accident	Transverse comminuted tibia and fibula	2 hrs.	Good	General ethylene	4 wks.	5 wks.	None used	Crutches with leg in boot used. Then an elastic bandage. Final results good
27	36205	18 M	Motor cycle accident	Compound comminuted tibia. Two transverse fractures of fibula	4 hrs.	Good	General ethylene	4 wks.	6 wks.	None used	Elastic bandage and crutches used instead of Delbet. Physiotherapy. End-results good
28	A 656	44 M	Auto accident	Compound comminuted oblique tibia and fibula	hr	Good	General ethylene	4 wks.	6 wks.	5 wks.	Good end-results

PLATE VII

overriding or shortening, are shown in Plates I to X. They have been so satisfactory that we rarely find occasion to use any other method except in unco-operative patients and very young children.

We believe that the results of treating the cases we have reported are of sufficient merit to warrant its indefinite continuance in this clinic. The fear of infection and necrosis, we do not believe need



Case No.	Height	Age	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anesthesia	Time in pain	Time in heat	Time to Defect	Comments
11	young	26 yr	Auto accident	spiral comminuted fracture of tibia. One oblique comminuted of fibula	48 hrs.	Poor	Local paravertebral %	7 wks.	6 wks.	4 wks.	Dulbecc treatment on admission. Controlled by pedicure. End results good
12	44 yr	26 yr	Auto accident	Comminuted comminuted oblique of tibia and fibula	12 hrs.	Poor	General ethylene	4 wks.	3 wks.	4 wks.	Radii checked on admission. Radii rapidly. End results functionally good
13	A 40	46 yr	Auto accident	Comminuted comminuted oblique of tibia. Questionable fracture of upper fibula does not show in photo	hrs.	Good	General gas and oxygen	4 wks.	3 wks.	3 wks.	Also severe dislocation of shoulder. Wound healed well under daily dressing. End results good
14	45 yr	46 yr	Fall off dock	Oblique of tibia. Comminuted oblique of fibula	hrs.	Fair	General ethylene	3 wks.	4 wks.	3 wks.	End results good. Callus somewhat slow in forming

PLATE VI

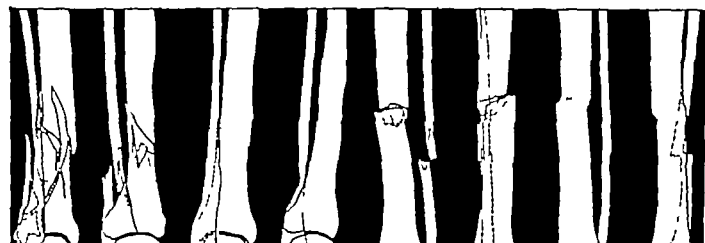
an elastic bandage. The Delbet splint was removed when the roentgenograms showed abundant firm callus.

RESULTS

Our results with this procedure in 39 cases of fracture of both bones of the leg, associated with



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ADMISSION CASE NO.33 DISCHARGE CASE NO.33 DISCHARGE CASE NO.34 DISCHARGE CASE NO.34

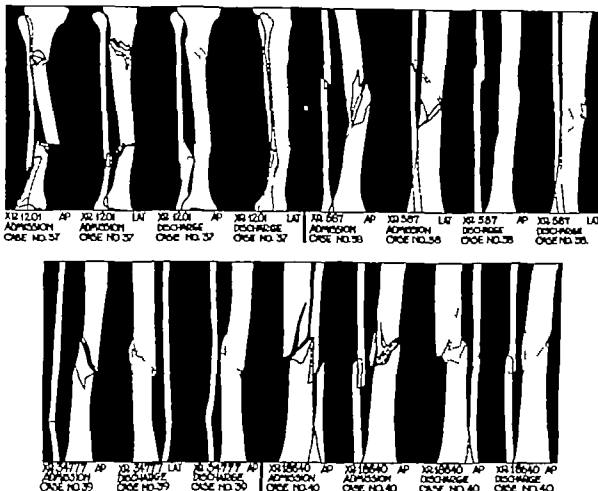


XR.4306 AP XR.4306 LAT XR.4306 AP XR.4306 LAT XR.4174 AP XR.4174 LAT
ADMISSION CASE NO.35 DISCHARGE CASE NO.35 DISCHARGE CASE NO.36 DISCHARGE CASE NO.36

Case No.	Hosp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anaesthesia	Time in pin	Time in boot	Time in Deltet	Comments
33	95440	38 M	Auto accident	Both right and left leg fractured. Right oblique comminuted tibia. Double transverse fibula	2 hrs.	Fair	General gas and oxygen	4 wks.	10 wks.	6 wks.	Came in shock. Rallied rapidly. Daily alcohol dressings. End-results good
34				Left double transverse comminuted tibia and fibula. Both compounded							
35	97317	38 M		Oblique comminuted both tibia and fibula	2 hrs.	Good	General gas and oxygen ether	4 wks.	8 wks.	None used	Cast bivalved. Tend of 6th week. Used crutches. Good results
36	A2998		Ran into a truck while on motor cycle	Transverse fracture of both tibia and fibula	2 hrs.	Fair	General gas and oxygen	4 wks.	6 wks.	4 wks.	Final result good

PLATE IX

compound fractures of this type we dismiss with the statement that it introduces an unnecessary foreign body, only complicating an already complex problem. The method we use appears to



Drawings by Robert HARRIS, M.D.

Case No.	Resp. No.	Age Sex	Etiology	Character of fracture	Elapsed time before hospitalization	Co-operation	Anesthesia	Time in post	Time in bed	Time in Deltet	Comments
37	A798	47 F	Struck by log	Double of tibia. Upper complete oblique comminuted. Lower transverse comminuted. Fibula complete transverse. Both comminuted	hrs.	Fair	General ethylene	4 wks	3 wks 1st 10 days rest on 4 wks. 2nd 10 wks. and then bilateral	None used	Cadon slow in forming. Angulation needed constant attention. Wound healed slowly. End results good
38	E607	66 F	Fell down stairs	Compound spiral of tibia. Simple transverse of fibula	4 hrs.	Fair	General ether	7 wks.	6 wks.	3 wks.	Tibial area developed low grade osteomyelitis in 2nd wk. Cleared completely by streptomycin. End results good
39	14481	9 F	Auto accident	Oblique comminuted tibia. Simple transverse fibula	3 hrs.	Fair	General ethylene	4 wks.	4 wks.	None used	Walking calipers used after 1st wk. Good results
40	1343	36 F	Auto accident	Complete transverse comminuted tibia and fibula	hrs.	Good	General gas and oxygen	4 wks	3 wks	4 wks.	End results good

meet every requirement in cases of great comminution where internal fixation is unsatisfactory or impossible. It may be applied quickly and safely under local anesthesia when a more prolonged procedure or general anesthesia is contra-indicated.

CONCLUSION

Skeletal traction, in the form of the Steinmann pin, is of considerable value in the treatment of fractures of both bones of the leg as we have found in the 39 cases reported from this clinic. The

method is simple and safe within the limitation of the operator's technique.

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- WILSON PHILLIP In discussion to article of Hilzrot above

RESECTIONS OF THE COMMON AND HEPATIC BILE DUCTS AND AMPULLA OF VATER FOR OBSTRUCTING LESIONS

RESULTS IN THIRTY CASES¹

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I SHALL present here my results in 30 cases following resection of the common and hepatic bile ducts and of the ampulla of Vater for relief of obstructive jaundice due to strictures and tumors.

The operative procedures can be divided into five groups (1) hepaticoduodenostomy, choledochoduodenostomy, and cholecystoduodenostomy (2) excision of the stricture or tumor with anastomosis of the ends of the duct (3) plastic operation for localized stricture consisting of longitudinal incision of the stricture followed by transverse closure after the method of a Heineke-Mikulicz pyloroplasty (4) transplantation of external biliary fistula, established when a sufficient amount of common or hepatic duct did not remain to enable anastomosis of the duct and the duodenum, and (5) resection of the ampulla of Vater for carcinoma.

Although the indications for these procedures will be considered later in detail, several conclusions have been drawn from a study of these cases and they will be enumerated here rather than at the termination of the paper. Thus any who have had experience in similar cases will be enabled to compare these conclusions with their own and to analyze the arguments in favor of each procedure. These conclusions are

1. If sufficient normal duct remains above the stricture to enable its accurate anastomosis without tension to an opening made in the duodenum thus obtaining union of mucous membrane to mucous membrane, results will be excellent, pro-

vided the liver is in satisfactory condition. Failure to obtain such a result can be attributed directly to inaccurate anastomosis, to severe infection of the parenchyma of the liver, or to infection in the walls of the biliary tract itself. Infection in either of the structures mentioned may be accompanied by sand like calculi within the biliary passages.

2. If the stricture or tumor is small or is situated directly adjacent to the liver with normal duct both proximal and distal to the stricture or tumor, excision of the lesion with subsequent direct anastomosis of the ends of the duct probably will be a satisfactory procedure, and can be expected to be followed in most cases by good results. Such is not usually the case, however, if the scarred portion is merely incised and allowed to remain even though the lumen of the duct at this point is increased by a plastic procedure of the Heineke-Mikulicz type. This may be explained by the fact that the remaining scar tissue continues to contract.

3. If the amount of duct which remains exterior to the liver is not sufficient to allow of either procedure, an external biliary fistula can be established and later coned out and transplanted into the stomach or duodenum. This may be expected to be followed with good results in some instances and fairly good results in others.

4. The frequency with which small tumors of the ampulla of Vater cause obstructive jaundice should not be forgotten. Since the tumor is usually small and of low degree of malignancy producing symptoms early and metastasizing late, it

¹Read before the Southern Surgical Association, White Sulphur Springs, West Virginia, December 8 to 10, 1931

thereby lends itself readily to transduodenal removal.

HEPATICODUODENOSTOMY CHOLEDOCHODUODENOSTOMY AND CHOLECYSTDUODENOSTOMY

Hepaticoduodenostomy or choledochoduodenostomy has been carried out in 15 cases (Tables I and II and Case 26) and cholecystoduodenostomy (Case 14) because of the greater ease of attachment to the duodenum without tension, in 1 case. Visible jaundice was present in all the value for bilirubin varied from 1.2 to 17.4 milligrams for each 100 cubic centimeters of serum. With two exceptions, all the patients had been operated on for disease of the biliary tract before they came to the clinic, the gall bladder according to the history having been removed or drained. In 2 cases in which operation had been performed at the clinic for stones of the common duct, there was marked infection throughout the biliary tract and especially in the walls of the duct itself evidences of recurring obstruction of the common duct (due to stricture) developed 4 years later in 1 case (Case 1) and 1 year later in the other (Case 5 in Table I). In all 16 cases, the duration of the jaundice varied from 43½ days to 2 years, and the obstruction manifested itself from as short a time as immediately following operation to 5 years after operation (Tables I, II and VI).

Excellent results are known to have followed operation for at least 5 years in 1 case, 4 years in 1 case, 3 years in 2 cases, more than 1 year in 3 cases, and less than 1 year in 2 cases. The index of excellence has been that the patients have regained their health subsequent to operation and have had no further evidence of biliary obstruction whether pain, jaundice, or chills and fever.

Two of the patients reported that they were in good health and free of constant jaundice, but that at times they had pain, transient jaundice or fever of short duration (Table II). In one of these cases (Case 11) jaundice had been present 3 months before hepaticoduodenostomy, cirrhosis of the liver graded 3+ was noted at operation, and a very short fringe of hepatic duct remained above the stricture. Further evidence of hepatic injury in this case was lengthening of the coagulation time to 16 minutes. In the other of these 2 cases (Case 12) bile drained externally for 6 months before hepaticoduodenostomy and in the intra-hepatic ducts were found sandy granular stones. In this instance, too, only a fringe of duct remained for anastomosis. Another patient (Case 9) under went choledochoduodenostomy in 1926 at which time intrabiliary stones were noted, in addition to the stricture. In 1927 a plastic operation was done

at the stoma made at choledochoduodenostomy and again stones were found. In 1930 I explored the anastomosis and the ducts. The anastomosis was in excellent condition, but in both the common and hepatic ducts were small granular stones. This patient continues, at times, to have occasional biliary colic. The value for bilirubin recently was 2 milligrams for each 100 cubic centimeters of serum, and on test of hepatic function retention of phenoltetrachlorophthalain was graded as maximal (grade 4) but on duodenal drainage a normal amount of bile of normal color was obtained. In other words, the condition of the patient, her symptoms, and the obstruction are results of hepatic and intrahepatic infection with formation of stones and are not due to contracture of the hepaticoduodenal anastomosis. In another case (Case 13), in which the value for bilirubin was 7.5 milligrams for each 100 cubic centimeters of serum, at operation stricture of the hepatic and common ducts extended almost to the hilum of the liver and only a fringe of normal duct remained above for anastomosis. After operation the patient was returned to the care of her family physician and it was recommended that the T tube remain in place for 1 year because of the inaccuracy of the anastomosis. It was advised further that should evidences of obstruction again occur it would be necessary to establish an external biliary fistula which later could be transplanted into the duodenum. The patient was free from evidence of biliary obstruction for a year when she again began to have intermittent attacks of colic, chills, and fever without jaundice. She has gained in weight, but states that her condition is not satisfactory. One of the most interesting cases of the group from the standpoint of showing the effect of hepatic injury on postoperative progress, is that of a young woman on whom I operated September 30, 1926 (Case 8) at which time she was deeply jaundiced and had been so for 3 months. I performed choledochoduodenostomy and she was well for 6 months subsequent to the operation then she began to have jaundice, chills and fever but no pain. Examination gave evidence of an enlarged liver and some jaundice of the skin but a normal amount of bile was obtained by duodenal drainage. While she was under observation ascites developed which responded to the use of mercurial diuretics. She returned October 3, 1927. She was not jaundiced and there was no ascites, but an enlarged liver was noted July 10, 1931 5 years following operation, she returned to the clinic with severe jaundice and an enlarged, palpable liver. She died from bronchopneumonia July 21, 1931.

TABLE I—HEPATICODUODENOSTOMY

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Postoperative progress
1	63 M	17.4	3-13-26	Jaundiced 45 days	Cholecystectomy and choledocholithotomy 1921	Excellent from 1927 to 1931 No tube
2	50 F	3.3	8-2-26	Jaundiced 5 months	Cholecystectomy (elsewhere) 1927	Excellent from 1928 to 1931 No tube
3	63 M	2.8	5-29-30	Intermittent fistula with jaundice and fever since operation	Cholecystectomy (elsewhere) Nov. 1929	Excellent in 1931
4	43 F	2.4	9-27-30	1 intermittent colics and jaundice for 9 months	Cholecystectomy (elsewhere) 1927	Good in 1930; excellent in 1931
5	51 M	7.4	6-16-31	1 intermittent colics and jaundice 1 month preop	Cholecystectomy and choledocholithotomy 1915; dilation of stricture of hepatic duct, 1926; choledochostomy 1927; choledocholithotomy, 1929; hepaticoduodenostomy (stones) 1931	Excellent, 11-20-31
6	50 F	1.8	10-13-31	Pain in right upper quadrant for years	Cholecystectomy 1920; cholecystectomy 1923; adhesions (elsewhere) 1923	

Had three intralipatic stones each approximately 1 cm. in diameter

As has been said one of the 16 patients (Case 14) was subjected to cholecystoduodenostomy for it was believed to be the preferable procedure. This patient had had biliary colic chills and fever for 2½ years and had been confined to bed for a year prior to her operation in January, 1926. This patient I presented at the staff meeting of the clinic on two occasions subsequent to her operation as an example of what seemed clinically to be hepatic regeneration (8). In the year subsequent to operation jaundice would occur at infrequent intervals. During the early part of 1928 she had no further jaundice her stools were normal, and she had no pain. In July, 1928 however she had slight hematemesis but on March 4, 1929 she was found to be in good condition except that retention of phenoltetrachlorophthalein was graded 2. She continued to be well until the early part of this year (1931) when she died from sudden hemorrhage, apparently the result of rupture of esophageal varices.

EXCISION OF LOCALIZED STRICTURE OR OF TUMOR, WITH DIRECT ANASTOMOSIS

I have used this method in 4 cases (Table III and Case 27 in table VI) in 3 of stricture and in 1 of neurofibroma. T tubes were used in the anastomosis in 3 of the cases and removed from 6 to 8 weeks subsequent to operation in 2. This method has been used when the stricture was localized was small in extent involved the ducts very near to the liver, and the duct was patent and of normal appearance distal to the stricture. Excellent results have been obtained in each of these cases, more than 3 years and 9 months have elapsed since the first patient was operated on (Table III). The fourth patient died 7 days after operation

from acute suppurative cholangitis and hemorrhage (Case 27).

The patient with the neurofibroma (Case 17) has been reported in detail previously (3). Suffice to say however, that after removal of the tumor the ends of the hepatic ducts were anastomosed to the distal end of the common bile duct over two small T tubes one of which was removed in 4 weeks and the other in 8 weeks.

Considering the excellent results obtained in the 3 cases in this group one may well ask why such a method is not preferable to anastomosing the duct and the duodenum. The answer is that it may be preferable when practicable, yet, I have found it applicable in but 4 of the 29 cases due to the large extent of the stricture and further more I have had the impression that over long periods of time there has been a greater tendency to recurrence of the obstruction at the site of such anastomosis than occurs following choledochoduodenostomy. Discussion of this point should be particularly interesting.

INCISION AND PLASTIC ENLARGEMENT OF THE STRICTURED PORTION

I have distinguished between this method and the preceding one, because in the former the fibrotic portion is completely removed whereas in the method now to be described, the fibrotic portion remains, and later may distort or again obstruct the anastomosed portion by continued contracture. This latter method was used in my earliest cases, and although one patient was free from symptoms of obstruction for 3 years, such symptoms then returned. Another patient has had no evidence of biliary obstruction over a period of 1 year, whereas a third patient has

TABLE II.—HEPATICODUODENOSTOMY AND CHOLECYSTDUODENOSTOMY

Case	Age and sex	Interval, months	Date of operation	Symptoms	Previous operation	Operative findings	Postoperative progress
7	6, F	4.7	6-30-25	Biliary fistula; slight jaundice	Cholecystectomy (elsewhere), 1913	Stricture at level of liver; inaccurate anastomosis	Left hospital in good condition, died at home six months later; color and jaundice.
8	5, F	1.6	9-30-26	Jaundice and colic, 3 months	Cholecystectomy (elsewhere), 1926	Live hypertrophied and color of pancreas	Jaundice, chills, fever and enlarged liver for 6 months, 10-3-27; no jaundice or colic; large liver, 7-10-27; jaundice, chills, fever and colic; 7-11-27; died bronchopneumonia.
9	16, F	4	5-1-28 4-1-30	Constipation, jaundice, colic, and fever since childbirth, 7-4-28	Choledochoduodenostomy 1921; pleuro and cholecystectomy 1927 and 1930	Intrahepatic stones, 1921; intrahepatic stones, 1927; intrahepatic stones, 1930; cholecystectomy 1927 and 1930	5-1-28 dismissed, T-tube slipped out, followed by brown colic, jaundice, and colic; July 9-28 and Aug. 1931 brown colic; jaundice graded 2, lower function graded 4.
10	45, F	6.3	8-2-27	Jaundice for years; postoperative biliary leakage	Cholecystectomy 1913; cholecystectomy (elsewhere), 1921	Stricture of lower third of common duct; cholecystectomy	Excellent until 1931; then occasional colic, jaundice, and fever
	6, F	3.3	2-19-28	Jaundice, 3 months	Cholecystectomy (elsewhere), 1926	Cirrhosis graded 4-1; slight hepatic congestion; bile 4 months	Excellent in 1928; chills and fever in 1929; chills, fever, jaundice, and colic in 1931
	7, F		7-4-29	Biliary drainage, 6 months postoperative; chronic jaundice and colic, jaundice weight lost	Cholecystectomy (elsewhere), 1926	Grossly stony cholelithiasis in hepatic duct; frage of hepatic duct	T-tube removed Oct. 1929; Nov. 1929 colic and slight jaundice; 6-9-31 discharged; occasional colic.
11	1, F	7.5	4-7-30	Jaundice and pain, weeks	Cholecystectomy and T-tube in common duct (elsewhere), 1926	Stricture of common duct acutely to liver; fringed duct; persistent leak; T-tube for 1 year	Sept., 1931 pain, chills, and fever no jaundice; condition not satisfactory
12	45, F	3.8	4-26	Jaundice and colic, 2.5 years	Cholecystectomy (elsewhere), 1913	Cholecystoduodenostomy	Died in 1926; July 1926 slight hemorrhage; good until 4-2-27; died of hemorrhage of esophagus.
13	5, F	7	4-30-26	Biliary fistula, 3 months postoperative; spasm of colic, fever, and jaundice of week's duration for 3 years; no weight loss	Cholecystectomy (elsewhere), 1921; cholecystectomy (elsewhere), 1923	Common duct stricture to within 3 mm of liver with stone plus 1 hepaticoduodenostomy over catheter	Catheter held in place by silk thread to entrance until 6-1-26; catheter passed through ampulla transanally 6-2-26; Sept., 1926 biliary obstruction, pain, fever, jaundice; thick bile; 10 days, jaundice 10 days; Oct. 1927 no attacks for 6 months; Aug., 1928 no attacks, good chills, died suddenly Jan., 1929 (hemorrhage?) sick days.

reported continued good results from operation for over a period of 5 years. I have not the faith in this procedure that may be warranted (Table IV).

In this group as in the preceding one, if it is desired to use a piece of tube or catheter to serve temporarily as a splint for healing and a channel for transmission of bile, experience seems to indicate that a T-tube is best. On three occasions I have had to remove tubes which had been left in the common duct. In 1 case this was required following choledocholithotomy performed elsewhere, in each of the 2 other cases a catheter extended from the duct through the ampulla of Vater into the duodenum and jejunum, and in spite of the fact that three-fourths of its length was in the intestine, intestinal peristalsis failed to detach the catheter from the bile ducts and it had remained in place for several years.

GASTRODUODENAL IMPLANTATION OF EXTERNAL BILIARY FISTULAS

When stricture is complete and involves the common and hepatic ducts, establishment of an external biliary fistula, which later can be coned out and transplanted into the duodenum has given very satisfactory results. Last year I reported 5 such cases in which I operated (9) in 3 of which excellent results have been obtained (Tables V and VI). In 1 of these 3 cases 3 years and 9 months have elapsed since the transplantation and in another, 2 years. Both patients are in excellent health (Cases 22 and 23). A transplanted fistula became strictured in a third patient (Case 24) necessitating re-implantation. A fairly good result has followed. If a patient presents himself with an external biliary fistula, having been operated on elsewhere, before transplantation of the fistula is considered, the condi-

TABLE III.—EXCISION OF STRICTURE OR TUMOR AND ANASTOMOSIS OF ENDS OF THE DUCT

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Results
16	32 M	3.8	2-7-28	Intermittent jaundice and colic, 2 years	Cholecystectomy (elsewhere) 1924	Excellent.
17	26 F	15.0	12-21-28	Jaundice and itching 5 months	Cholecystectomy (elsewhere) July 1929	Excellent. T-tube remained in for several weeks.
18	43 F	11.5	10-11-30	Biliary fistula, 4 1/2 months post-operative. Intermittent jaundice and itching 5 years, chills and fever	Cholecystectomy (elsewhere) 1920—liver enlarged and firm neurofibroma obstructing common duct removed	Excellent; T-tube remained in for several weeks.

TABLE IV.—PLASTIC OPERATIONS FOR LOCALIZED STRICTURES

Case	Age and sex	Serum bilirubin	Date of operation	Symptoms	Previous operations	Operative findings	Postoperative progress
19	41 F	0.5	8-6-25	Colic 5 months, jaundice	Drainage, gall bladder and stones removed (elsewhere) 1924	Incomplete stricture common duct at cystic duct; gall bladder contracted to small fibrous mass 1.5 cm. in diameter	Dec., 1926 jaundice, slight pain. Sept., 1927 jaundice and pain absent since 1926, occasionally slight jaundice chills and fever 10-7-30 good.
20	30 F	9.0	7-30-25	Colic and jaundice years	Cholecystectomy (elsewhere) 1919	Stricture 2 cm.; re-contracted over catheter; excision duodenal ulcer	Jaundice recurred, 1928 excellent last 3 months, 1929 catheter removed at jejunotomy 1930 intermittent chills and fever 2-5-31
21	38 F	1.4	4-6-29	Biliary colic, 6 weeks, questionable jaundice	Gall-bladder operation (elsewhere) Nov. 1926	Incomplete stricture at junction of common and cystic ducts	T-tube removed 7-8-29; condition good; 8-28-30 operation successful.

tion of the common and hepatic bile ducts, and of the gall bladder should it remain must be ascertained. For example, if material resembling white of egg is excreted the probabilities are that the gall bladder remains and that there is a stone in the cystic duct. When bile is excreted the probabilities are that the obstruction is in the common bile duct and that it is caused by stone, by stricture, or by tumor in the head of the pancreas. If transplantation of an external biliary fistula is deemed the procedure of choice it must adequately drain the intrahepatic ducts, and these ducts must be free of stones, otherwise the obstruction will recur. Furthermore the possibility of a more certainly curative type of operative procedure, namely, hepaticoduodenostomy should be considered if sufficient normal duct remains above the stricture or the fistula to enable the duct and the duodenum to be accurately anastomosed.

In May, 1930, I operated on a patient (Case 3) who had undergone cholecystectomy elsewhere in November, 1929, for relief of gall bladder colic, which had been present for 21 years. Subsequent to the cholecystectomy a biliary fistula had developed. When the fistula closed, jaundice and fever would occur and would continue until the fistulous tract again opened and bile was discharged. At operation, the fistula was found to

terminate exterior to a stump of common duct, which was dilated and was 1.5 centimeters in length and 1.5 centimeters in width. The large size of the common duct above the stricture made transplantation of the distal end of the fistula into the duodenum the advisable procedure, this was not done however until three stones, the largest 1 centimeter in width had been removed from the intrahepatic ducts. Had the stones been over looked they might not have been discharged spontaneously through the anastomosis and symptoms of obstruction might have recurred, thus discrediting the type of anastomosis used. The patient has been in excellent health and without any further evidences of biliary obstruction since his operation.

RESECTIONS OF THE AMPULLA OF VATER

The cardinal symptoms of lesions of the ampulla of Vater are icterus, distention of the gall bladder and chronic obstipation. Mueller called attention to the fact that probably the most common region of origin of the ampullary growth is the duodenal mucosa at the papilla, where an ulcer may develop, and that jaundice, the main symptom, is present except in a few cases in which ulceration of the lesion permits a channel to form through it for the passage of the bile. Such a lesion

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FEBRUARY 1933

THE SURGICAL ASPECTS OF SUPRARENAL ABNORMALITIES

AMONG the interesting advances in surgery have been the identification and surgical removal of tumors of the parathyroid bodies and of adenomata of the pancreas. The effect of both these growths is to increase the activity of the structures in which they are situated: tumors of the parathyroid bodies increase the excretion of calcium derived from the skeletal reserves and those of the pancreas cause overproduction of insulin with hypoglycæmia. Identification and removal of such tumors have restored to normal the metabolic activities of the structure in which the tumors were situated.

Further studies on abnormalities of the other ductless glands would indicate that tumors developing in them give rise to characteristic symptoms. Structurally the suprarenal glands are composed of two distinct parts, the cortex taking its derivative from the mesoderm of the Wolffian body and the medulla from the sympathetic nervous system. Tumors arising from the medullary substance are neuroblastomata, ganglioneuro-

mata, and paragangliomata. Neuroblastoma metastasizes early to the liver and lungs in the adult, and to the skull and long bones in children. The ganglioneuroma, benign in type produces no characteristic clinical symptoms. It is usually found unexpectedly at necropsy. Most important tumors of the medullary portion of the suprarenal gland are paragangliomata, benign in character characterized clinically by attacks of paroxysmal hypertension. Excellent results over periods of more than six years have resulted following removal of suprarenal paragangliomata by Mayo Shipley and Porter.

The most frequently occurring suprarenal tumor is that involving the cortex. Several excellent summaries of reported cases have appeared in the literature. To the signs and symptoms thought to be pathognomonic of such tumors Gallais has applied the name *Le syndrome génito-surrénal* and Krabbé that of "adrenal hirsutism." Briefly the syndrome is accompanied by heterosexual changes, such as virilism, hirsutism, amenorrhœa, and occasionally hyperglycæmia with glycosuria. After removal of this type of suprarenal tumor the secondary sexual characteristics have reverted essentially to normal as reported by Colletts and Gordon Holmes.

Clinically and experimentally Marine and Jaffé have shown that an intimate relationship exists between the suprarenal body and the other ductless glands. Further support to their thesis is the fact that in the past year Cushing has collected a group of fourteen cases, the clinical picture of which has been similar to that in cases of tumor of the suprarenal cortex, and in many of these cases he

has found basophilic adenomata of the pituitary gland to be present, sometimes the tumors were so small that it was necessary to study the pituitary body in serial section in order to demonstrate their presence. Inasmuch as in most such cases examination of the suprarenal gland gives no evidence of tumor, but in the occasional case there is hypertrophy of the cortical portion of the structure it becomes necessary to approach the problem from the other angle—namely, to determine whether or not patients with syndromes suggesting tumors of the suprarenal cortex may not also have adenomata of the pituitary body. It might seem that this adds to the complexity of making a differential diagnosis between the two lesions. Such, however, should not be the case, since in many instances the suprarenal tumor can easily be palpated through the abdominal wall, or gives evidence of its presence by displacement of the kidney, furthermore in doubtful cases, extraperitoneal exploration of the suprarenal gland can be carried out with ease and comparative safety. Transperitoneal abdominal exploration of the suprarenal glands enables one at the same time to determine the condition of the liver as well as of the ovaries, and particular importance should be attached to the ovaries because of the fact that a particular type of ovarian tumor, called arrhenoblastoma, may be accompanied by symptoms of virilism and hirsutism as reported by Robert Meyer of Germany, and Krock, Taylor, and Wolfertman in this country. That such a syndrome is also associated with arrhenoblastoma of the ovary may be explainable by the fact that embryologically, the ovary takes its origin from the wolffian ridge in common with the suprarenal cortex and testes.

As previously stated, since removal of a cortical tumor of the suprarenal alone has

been followed by reversion to normal of secondary sexual characteristics, it would be of great interest to note whether or not the removal of the arrhenoblastomata of the ovary and roentgen treatment of basophilic pituitary adenomata would be followed by similar results.

Even a brief discussion of *Le syndrome génito-surrénal* as characteristic of tumors of the suprarenal cortex would be incomplete without emphasizing the fact that large tumors of the suprarenal gland may occur without this syndrome being present. This is particularly well illustrated in the case of a young woman, aged 32 years, from whom a hypernephroma of the right suprarenal gland, 12.5 by 10 centimeters in diameter, was removed. Although she had had amenorrhea for eighteen months and had had recurring weekly attacks of pain in the right upper abdominal quadrant, with chills and fever, virilism, hirsutism, or paroxysmal hypertension was not present. Three months following the removal of the hypernephroma, the patient had gained twenty pounds in weight, had had two normal menstrual periods, and had been completely relieved of the attacks of abdominal pain and fever.

The statement of Rowntree and Ball concerning suprarenal tumors is worthy of quotation: "The complexity of the whole problem is especially striking. In many cases, clinical and pathological data indicate involvement of some particular portion of the suprarenal gland and the diagnosis is definite and clear cut. In other instances, complexity of the clinical picture would seem to point to involvement of both medulla and cortex."

This statement, I believe, would apply equally well to cases in which tumors of any of the ductless glands has resulted in *Le syndrome génito-surrénal*.

WALTMAN WALTERS

THE OCCLUSION OF LARGE BRONCHI

THE delay of the development of thoracic surgery was probably due more to the fears and dangers of open pneumothorax than to any other one factor. Satisfactory methods for maintaining adequate respiration in the presence of large openings into the chest have obviated to a large extent this difficulty. Probably the second most important factor that served as a deterrent to the development of thoracic surgery has been the absence of a method by which large bronchi may be occluded with safety. The problem is not a new one as Hippocrates is quoted as giving up in despair in his attempts at causing permanent bronchial fistulae to heal and advising letting nature take its course."

Many different kinds of procedures have been tried on animals in an attempt to find a satisfactory method of occluding large bronchi. It has been the experience of most investigators that it is not difficult to maintain closure of a bronchus following a lobectomy but that the bronchial stump usually reopens following a pneumectomy. Bettmann believes that the successful closure of a large bronchus depends upon its being covered by peribronchial tissue and that pneumectomy can not be performed safely because of the absence of enough tissue to cover the stump. Heuer alone has had a low mortality rate in performing pneumectomies in dogs. Most of the methods which he tried gave good results. These results in which an entire lung was removed were very encouraging but it is to be remembered that the conditions differed from that encountered in the human in that infection was not present and also in that the extremely movable mediastinum of the dog allows shifting of the remaining intrathoracic organs.

The most encouraging results by a method which has probably the largest field of therapeutic application are those that have been obtained recently by Adams and his associates of the Department of Surgery of the University of Chicago. Their experiments were performed on dogs. Adams and Livingstone found that complete stenosis of a bronchus 0.5 inches in diameter was a routine occurrence within 2 weeks following the application of a 35 per cent solution of silver nitrate. A small pledget of cotton attached to a wire rod was saturated with the silver nitrate solution and it was introduced into a bronchus through a bronchoscope where it was allowed to remain for about 10 seconds. Stenosis of the lumen of the bronchus was accomplished by a collapse of its wall and by the filling in of the lumen by the injured elements of the wall and granulations. Subsequently fibrous tissue formation took place. If necrosis of the entire bronchial wall were produced, only the epithelium regenerated. Massive atelectasis was associated with the complete stenosis of the main bronchus of a lobe. The use of 50 and 75 per cent solutions of silver nitrate were sometimes followed by death due to pulmonary hemorrhage.

Adams and his associates have used this method in treating pathological conditions that were produced experimentally. Persistent bronchial fistulae were produced in dogs by a method which they describe. Prompt closure of the fistula took place in all experiments in from 8 to 14 days following the application of the silver nitrate.

Adams obtained little success in his attempts to close bronchi draining pyogenic lung abscesses in dogs. The abscesses were produced by the Holman-Cutler technique in 8 dogs. Efforts were made to occlude the bronchus of the affected lobe in four of these. Complete stenosis of the bronchi was obtained

in 2 dogs after cauterization had been performed four and six times, respectively. This occurred 3 and 4 months after embolization, by which time the abscesses had healed with cessation of drainage through the bronchi. He concludes that pyogenic abscess cavities healed more slowly when stenosis was attempted than when it was not attempted. On the contrary, when abscesses were produced by emboli containing human tubercle bacilli, it was found that healing usually took place more rapidly in the animals in which the bronchus of the diseased lobe was cauterized.

Probably the most significant results were obtained by Adams and Vorwald in additional experiments in which widespread pulmonary tuberculosis was produced in dogs by the introduction of human tubercle bacilli into the blood stream. A saline suspension of human tubercle bacilli was injected into the femoral vein. Two to 6 weeks later massive atelectasis of two of the lobes of the lungs of each dog was produced. The animals which had not died by the end of 4 months were sacrificed. Few or no tubercles were found in the atelectatic lobes, whereas the inflated lobes were studded with millary tubercles. Microscopic examination revealed an occasional small tubercle in the collapsed tissue, while in the inflated lung were many large tubercles with caseating centers. In other experiments, tubercle bacilli were injected into the left

pulmonary artery. The left primary bronchus received an application of silver nitrate 2 to 6 weeks later. At autopsy, varying amounts of tuberculosis were found in the inflated right lung while the atelectatic left lung showed no gross involvement.

As to whether or not the brilliant results that were obtained by Adams and his associates in their experimental work can be duplicated in patients, it is too early to state. The method probably will not be effective in pyogenic infections unless there is an associated fistula to the exterior which allows adequate drainage. One would not, I think, expect to be able to close by silver nitrate a bronchus communicating with a large tuberculous cavity that was associated with a productive cough. Even though such a bronchus could be closed, it might prove unwise to do so. It would seem that one should be able to close by this method the bronchus to a lobe in which the non-productive type of tuberculous lesion is present. As a preliminary to lobectomy for tumors, it should lower greatly the mortality rate if satisfactory occlusion of the bronchus can be produced. The very least that can be said for this simple method that may be far reaching in its therapeutic application is that it supplies an additional means by which many problems connected with the surgery and physiology of the lungs may be attacked experimentally.

ALFRED BLALOCK.

MASTER SURGEONS OF AMERICA

LEVI COOPER LANE

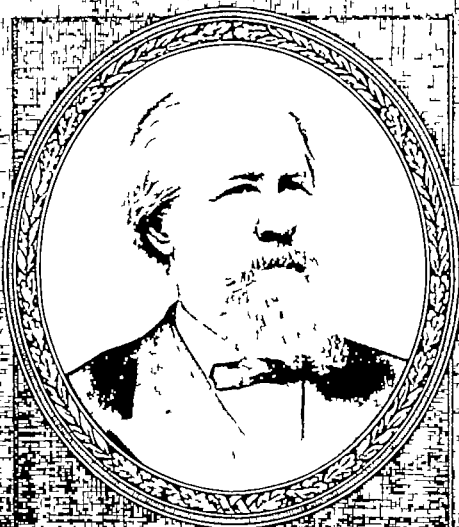
SURGEON founder of Cooper Medical College, now the Medical Department of Stanford University builder of the college buildings and Lane hospital founder of the Lane Popular Lectures (1881) the Lane Medical Lectures (1896) and the Lane Medical Library—this was Levi Cooper Lane.

Dr Lane was a man of strong character activated by a single purpose, namely to advance to the limit of his capacity the cause of scientific medicine To this end he devoted his life with a persistence which, against the handicap of delicate health, knew no check but rose above any discouragement.

Of pure English (Quaker) stock the oldest of nine children of Ira Lane and Hannah Cooper Levi Cooper Lane was born on a farm at West Elkton near Somerville, Ohio May 9 1828¹ His paternal grandparents came from North Carolina and his maternal from South Carolina, crossing the Cumberland Gap in 1807 He had some preliminary education at Farmers College, took his academic course at the Union Theological Seminary Schenectady New York which institution later granted him the degree of Master of Arts and in 1887 that of Doctor of Laws. In 1851 he was graduated from Jefferson Medical College, Philadelphia.

He spent the following four years as interne and house officer at Ward's Island New York, and in 1855 passed examination for entrance into the Medical Corps of the United States Navy receiving the highest mark of a class of one hundred a mark which remained the highest in navy examinations for nearly fifty years. In the great Naval Hospital at Quarantine Staten Island New York (3000 beds) he learned to know typhoid fever He knew it only too well, for he contracted the disease and was desperately ill He used to say 'These young men have to use a thermometer to make the diagnosis of typhoid fever They do not know typhoid. His sea duty was on the U.S.S Decatur and while his ship was in European waters he spent two months in study in Goettingen on furlough. He spent two years on the coast of Central America where he learned Spanish and in 1858 at Chinandagua, Guatemala, he performed his first operation for gonorrhea. It is of some interest to note that his vessel was the refuge of some of Filibuster Walker's men

¹ Due to discrepancies in family records the date of Dr. Lane's birth has been variously given as 1826 and 1829, but the former is the date undertaken by Dr. Lane himself and recorded by him.



LEVI COOPER LANE
1828-1902

Dr Lane resigned from the navy in 1859, and at the invitation of his uncle, Elias Samuel Cooper who founded the first medical college on the Pacific coast (1858), joined him in the practice of surgery in San Francisco and entered the faculty of the medical school as professor of physiology

After Cooper's death in 1862 the school languished, and when in 1864 Dr Hugh H Toland founded the Toland Medical College (now the medical department of the University of California), erecting a commodious building, Lane with several other members of the old faculty became teachers in that institution. In 1870 Dr Lane resigned from Toland College and reorganized the old school

Two years (1874-1876) Dr Lane spent in Europe in intensive study. He attended a course in pathology by Virchow and in London received the degree of 'M R C S'

In 1881 Dr Lane without so much as consulting his faculty, built a great college building and invited the faculty of the medical college of the Pacific, as the old school was called, to join him in developing a new school to be known as Cooper Medical College in honor of his uncle.

It is interesting to note that the gift of the building was on condition that there be given by the faculty each winter a course of popular medical lectures. This course of lectures has been given annually ever since, the fiftieth course being completed this year. In this matter of the instruction of the general public in medical science Dr Lane was at least thirty years ahead of his time.

In 1890 Dr Lane built an addition to the College building, doubling its size and in 1894 built Lane Hospital (250 beds). He was proud to state that he had built these buildings 'with moneys earned by himself in his profession'

Among the most far reaching of Dr Lane's accomplishments was the founding of the Lane Medical Lectures, for students and practitioners. The happy choice of William Macewen, regius professor of surgery, University of Glasgow, to inaugurate the course, gave the lectures such prestige that there has never been any difficulty in securing as lecturers men of the highest attainment in medicine, surgery, and medical research, such as Sir Michael Foster, Sir Thomas Clifford Allbutt, William H Welch and Sir Patrick Manson.

Dr Lane died February 18, 1902. By the will of his widow, whose death occurred the following August, one-third of his estate was given to Cooper Medical College, all that could be given by the then law of the State of California, for the purposes of a medical library. This library, since known as the Lane Medical Library, is the largest and most complete west of Chicago, and ranks perhaps fifth in importance in the United States. It is not merely a College library, but is administered for the benefit of the medical profession.

Though never robust physically, Dr Lane, by virtue of self discipline and perseverance, conducted an enormous medical and surgical practice. All his life he was a student. He early learned to divide his sleep, working at his books the

larger part of every night. Six nights in the week he read medicine, the seventh general literature. He read easily Greek Latin French, German Italian, and Spanish. As an exercise in Greek he religiously read Hippocrates once a year.

He wrote comparatively little, his thesis on "External Urethrotomy" and one or two other papers were in Latin, in addition there were a few medical papers e.g., on supracondyloid fracture of the elbow read before the American Surgical Association 1895 a few pamphlets, mostly controversial, for he lived in a period when personalities were prominent. In the matter of the supracondyloid fracture of the elbow he insisted upon the 'straight position, molding the joint daily by passive flexion. He secured excellent results, doubtless more because of the molding of the soft callus than the position of retention. But he was wont to classify surgeons as good or not according to whether they treated fracture of the elbow in the straight position or otherwise.

He translated Billroth's *Surgical Pathology* for his students laboriously writing out the translation in blank books and finishing this or that chapter as seen by his notes, at three or four in the morning. He projected a great textbook on surgery in three volumes, but lived only to complete the first, *Surgery of the Head and Neck* which, though perhaps ill timed nevertheless is a mine of personal observation rich in reference to the surgery of the nineteenth century.

A skillful anatomist he maintained for many years a small private dissecting room where he was wont to prepare himself for any unusual operation by dissecting the part ahead of time.

He was a humanitarian of intense feeling for the unfortunate, and while not interested in the conventional organized charities, did much private charitable work, and no one knows how much. He said 'It is a great thing to relieve pain. A keen observer of human character he had no patience with a shirk or a malingerer and his incisive tongue and classical vocabulary left no misunderstanding as to the duty of the individual to society but on the other hand he often said he wished no man to feel too poor to have his services. I heard him say that any man who had been in Andersonville or Libby prison could have his services without charge.

If one were to seek a single word to indicate the dominant feature of his character it would be loyalty for his friend could do no wrong and his enemy no right. How penetrating the glance of his keen blue eyes as he sought loyalty in others!

As a surgeon his methods were not brilliant but simple and direct. He was not greatly original and yet at the instance of a mother whose child was afflicted with microcephalus, who asked him could he not unlock her baby's brain and give it a chance to expand, he performed a craniotomy similar to that done by Lan- nelongue many years later. Vaginal hysterectomy he worked out as an original anatomical problem before 1880 not being aware that the operation had been

done in France in the early years of the nineteenth century and had been forgotten. He was a pioneer in suprapubic prostatectomy and devised a long pair of scissors with suitable curve for cutting away the middle and lateral lobes of the gland, guided by a finger in the bladder. He did much work on goiter and was very successful. His method in pre-antiseptic days was to shell out encapsulated adenomata and in diffuse goiter to transfix the gland with a peculiarly shaped transfixing forceps of his own design, cutting the tissue between ligatures, therefore, with little bleeding. He called thyroidectomy the operation of a hundred ligatures. He used silk for ligatures and left the ends hanging out of the wound for drainage to be drawn out as they became loosened. He performed many notable operations, having the courage to attack the most desperate cases. On one occasion, while operating for extensive cancer of the mouth, he was obliged to ligate the common carotid and in a few hours ligated the other, practically simultaneous ligation of both common carotids. The man lived for a number of years, a monument perhaps more to the size of his vertebral arteries than to the prowess of his surgeon. He ligated the abdominal aorta for aneurysm but never published the case. The man lived four or five days, when, pulling himself up into a sitting position, he strained and tore open the artery.

Towards the end of his career he was afflicted with a slowly progressive disease, purulent bronchitis, and some said he suffered from diabetes. He was engaged in writing the second volume of his textbook on surgery, *Surgery of the Chest and Abdomen*, struggling to complete it. At first he wrote twenty pages in a night, then fifteen and then ten, and as his weakness progressed the pages gradually diminished to three but he wrote these three, then two and finally one day before he was obliged to give up.

He had no children, but Cooper Medical College was to him a child. Feeling that the institution had been built up by the devotion and self sacrifice of himself and faculty (surely the young men who succeeded him could carry on with similar devotion), he had inserted into the deeds of the property to the corporation clauses to the effect that should the directors at any time cause the college to be united with any other institution, the property should automatically revert to the state. However, shortly before his death it was gradually borne in upon him that the cost of medical education was increasing by leaps and bounds, that substantial salaries had to be paid to the non practicing members of the faculty, the physiologist, the anatomist, the pathologist, the chemist, and the bacteriologist, and costly laboratories must supplant the lecture room. There was in sight no adequate endowment. Therefore, realizing that the institution could not stand alone and remain a class A medical school, he had the entire property deeded to him by the corporation, whereupon he redeeded it to the college with restrictive clauses omitted. He went further and entered into negotiations David Starr Jordan, president of Stanford University, looking toward the

sorption of the school in that University. The amalgamation took place in 1909, seven years after Dr. Lane's death. The conditions on which the directors of the college deeded the College property to Stanford University were simply that the property should be used for purposes of medical education in the sense of teaching young men and young women to be practitioners of medicine and that Dr. Lane's memory should be suitably preserved. Since buildings become out of date and have to be replaced, Dr. Lane's real monument is the Lane Medical Library and the Lane course of Medical Lectures—more enduring than brick or stone.

EMMET REXFORD

EARLY AMERICAN MEDICAL SCHOOLS

THE MEDICAL COLLEGE OF VIRGINIA

WYNDHAM B. BLANTON, M.D., RICHMOND, VIRGINIA

THE third medical school to be established in Virginia was organized in Richmond in 1838 as the Medical Department of Hampden Sidney College. It began as a private venture inaugurated by a group of young men several of whom had previously taught in other institutions. It was hoped that the new institution would attract some of the 400 and more students who were every year leaving Virginia for study in Northern medical schools. The founders were an exceptional group of men. Augustus L. Warner (—1847), graduate of the University of Maryland and fresh from the chair of anatomy and surgery in the University of Virginia, became dean and professor of surgery and surgical anatomy. He possessed marked ability as an administrator and surgeon and was the moving spirit in the new enterprise. John Cullen (1797-1849), native of Ireland and graduate of the University of Pennsylvania, was accorded the chair of the theory and practice of medicine, adorning it until his death in 1849. Lewis Webb Chamberlayne (1798-1854) of proud Virginia ancestry, likewise a graduate of the University of Pennsylvania, held the chair of materia medica and therapeutics. Socrates Maupin (1808-1871), 'a quiet little gentleman' and a graduate of the Medical Department of the University of Virginia, assumed the chair of chemistry and pharmacy. In 1853 he resigned to accept a similar position in his alma mater where he was shortly honored by being made chairman of the faculty. Richard Lafon Bohannon (—1887), still another graduate of the University of Pennsylvania, was made professor of obstetrics and the diseases of women and children, a position he acceptably filled until his death in 1887. Thomas Johnson became professor of anatomy and physiology. He had enjoyed the advantages of study in France under Laennec and had recently taught anatomy and surgery in the University of Virginia.

The College opened its doors in the old Union Hotel on East Main Street which had been converted into creditable teaching quarters and an infirmary. There was an impressive anatomical

museum and excellent chemical apparatus. In a short while plans were under way for a much more elaborate building and an entirely new structure on Shockoe Hill was soon ready for occupancy. The Egyptian building as it is still called was erected on land donated by the city with money loaned by the Legislature from its Literary Fund. The catalogue of 1845 announced that 'the magnificent and commodious College Edifice has been completed'. Lecture rooms, dissecting hall, infirmary were all under one roof.

The enrollment steadily grew from 46 in 1838 to 80 in 1851. The attendance did not exceed this number until the Civil War when classes of more than 200 were taught. Ninety per cent of the students were from Virginia. The tickets of each professor were paid for separately, and for many years averaged between 15 and 20 dollars a student.

The course of instruction was modeled after that of the older Northern schools. It consisted of two sessions of 4 months each, the second a repetition of the first. Graduation was contingent on two terms of study preceded by a year under some reputable physician, or attendance on the summer course, a thesis, an oral examination, and a fee of twenty five dollars. In the catalogues stress was laid upon the advantages the school had to offer Southern students—unlimited material for anatomical dissection, bedside instruction in an infirmary purposely housed under the same roof as the college, and the opportunity to study diseases peculiar to the South in their native habitat. In fact the type of clinical instruction given offering as it did, ready access to ward patients and ample opportunity to follow in each case the progress of disease, was loudly proclaimed as superior to the amphitheater method which was then so popular in Philadelphia.

This tranquil course of events was disturbed in 1854 by an unhappy schism arising out of a disagreement as to who had the right to appoint new members to the faculty, the Board of Hampden Sidney College or the medical faculty itself. The



Fig. 1 Old Union Hotel, Nineteenth and Main Streets, first building occupied by Medical Department of Hampden-Skibey College

quarrel assumed large proportions and excited a heated pamphlet warfare. It was ultimately settled by the legislature granting the medical faculty a new and separate charter. Thereafter the school was known as the Medical College of Virginia.

The new freedom was dearly bought, because a large element of the profession of Virginia was from this time on allied against the institution. This element controlled the medical journals of the state and until the Civil War violently attacked the faculty, relentlessly exposing every weakness of the college. Dr B. R. Wellford, the professor of materia medica and therapeutics, a man of national reputation and unimpeachable character, bore the brunt of the attacks, choosing as he did to become the mouthpiece of the faculty.

In spite of outside interference the institution made progress and some exceptional men were to be found in her faculty during this period. Jeffries Wyman succeeded Thomas Johnson and gave great and lasting impulse to the teaching of anatomy in the school. Under him the anatomical and pathological museum grew apace. Wyman terminated his teaching in Richmond to become

Hersey professor of anatomy at Harvard. Meredith Clymer who held the chair of medicine from 1848-1849 subsequently occupied several professorships in the North and achieved distinction in the field of nervous and mental diseases. More memorable was the brief occupancy of the chair of the Institutes of Medicine by Charles Edward Brown-Sequard. The famous savant taught in the college for a single session. He filled the basement of the college building with experimental animals, let down into his own stomach sponges on strings, withdrew them before the class to demonstrate digestive fluids in action, and did many another novel and startling thing to the delight and wonder of his class. His passionate love of science and the facility he possessed of compelling nature to reveal her secrets for first-hand observation, made a lasting impression on his students.

The Civil War added immensely to the responsibilities of the college. In the fall of 1859 Dr Hunter McGuire was successfully conducting an extramural school in Philadelphia. Through his personal influence and effort the Southern students in both the University of Pennsylvania



Fig 2 Egyptian Building

and Jefferson were assembled and transferred *en masse* to Richmond. Two hundred and fifty strong they were met at the station by enthusiastic citizens and students and later welcomed by Governor Wise in an address in the Capitol Square. Many of these students elected to continue their course in the Medical College of Virginia. This trebled the student body and taxed the institution to capacity. The Legislature rallied to the support of the college voting thirty thousand dollars for a new hospital which was shortly erected adjacent to the college. Throughout the period of the war the faculty taught at fever heat, giving two courses a year. It was the only Southern medical school which never closed its doors during the period of hostilities. Thousands of soldiers were cared for by the faculty and students. Several of the faculty in addition to their teaching positions, held important posts in the military service of the Confederacy. Charles Bell Gibson, professor of surgery was surgeon in chief for the Virginia forces. James B McCaw professor of chemistry and pharmacy was in charge of the Chimborazo Hospital, an institution that cared for more than 75,000 sick and wounded during the war. The graduation of large medical classes twice a year and the entrance of these graduates into the medical service of the Confederacy was no small part of the contribution of the college to the cause of the South.

The college faced the *post bellum* reconstruction bravely. In spite of poverty and a student body reduced at one time to a bare corporal's guard, efforts were steadily made to improve the standards of teaching and to give the students access to better clinical material. Clinical instruction was offered in Howard's Grove Hospital—an institution of five hundred beds—the college hospital, the Richmond Almshouse, and the City Dispensary.

The faculty after the war was composed of R. T. Coleman in the chair of obstetrics, D. H. Tucker in medicine, J. S. Wellford in therapeutics, J. B. McCaw in chemistry, A. E. Petricolas in anatomy, and Hunter McGuire in surgery. Naturally many changes were wrought as time went on. In 1881 Hunter McGuire resigned and was succeeded by J. S. D. Cullen, of almost equally illustrious war record. Frank D. Cunningham followed Samuel Logan in anatomy in 1867. E. S. Gaillard, editor of *Gaillard's Medical Journal* taught pathology from 1867-68. Levin S. Joynes and Otis F. Manson were added to the faculty.

The elevation of standards came slowly—too slowly for the critics of the college. The old charge of a "closed corporation," an institution run for personal advantage, began to appear in the journals. The fees were said to have been cut, scholarships abused, and the two short courses



Fig. 3. McGuire Hall, principal teaching unit, Medical College of Virginia.

for graduation were held to be entirely inadequate in preparation for the practice of medicine.¹ *The Journal of the American Medical Association* in two withering editorials, charged that the faculty was opposed to the medical examining board and had sanctioned the appearance of their students before a committee of the legislature asking exemption from the state examination. This was convincing evidence to the *Journal* that the work of the college was not what it should be. The Governor of the state took a hand and appointed an entirely new board of trustees. After months of futile effort to obtain control of the college, the matter was settled in the courts in favor of the old board.

In May 1893, a rival school the University College of Medicine was organized in Richmond. At its head was Hunter McGuire, a former professor of surgery in the old school, whose reputation was now at its height. About him a large faculty was gathered to teach medicine dentistry and pharmacy as the three departments of the new school. From the first this school attracted a large attendance. The enrollment the second year was 180. A graded course was offered in all departments and in medicine extended over 3 years. The institution first occupied the former residence of Alexander H. Stephens, vice-president of the Confederacy. In a few years it was in

possession of a new building of its own. A disastrous fire in 1910 produced a desperate situation from which the institution was rescued by the munificent contribution of \$100,000 from the citizens of Richmond toward the erection of another new building. The Virginia Hospital with 125 beds, a training school and "a large corps of trained nurses" was close by and under the entire control of the faculty.

The presence of the new school was an admirable stimulus to better medical teaching in Richmond. The old college began at once to look to its laurels. The faculty was enlarged and George Ben Johnston, who at this time became professor of surgery asserting his natural gift of leadership assumed much the same rôle in the old school that Dr. McGuire did in the new. From now on it was a battle between these superior men and their respective faculties. The old school began by reorganizing its hospital which after 1895 was known as the Old Dominion Hospital. A school of nursing was instituted by Miss Sadie Henth Cabaniss, a graduate of Johns Hopkins Hospital under Miss Isabel Hampton. Under her high ideals and strict discipline it became a school to be proud of. The medical curriculum was expanded and lengthened until in 1894 it became a 3 year graded course of instruction and in 1897 in imitation of its rival, it was subdivided into the three departments of medicine, dentistry and pharmacy. In 1899 the 4 year course was adopted. To its surprise the presence of a competitor instead

¹ It is fully to say that students on admission were required to have studied under an approved preceptor for 1 year, and that in addition to the two short terms an extended summer course was offered by the faculty.

of reducing its enrollment increased it so that by 1895 its students numbered 139. The intense rivalry of the two institutions created two bitter factions in the medical profession of Richmond, but it put nearly every physician to studying and teaching medicine and accomplished what the old school alone had not been able to do—it stemmed the tide of Virginia students seeking a medical education in Northern institutions. In a single year Virginia medical students in Virginia institutions increased from 225 to 450.

Such a situation in a city as small as Richmond could not always endure. It became more and more difficult to find money to support both schools, for both had radically reduced tuitions—

in the case of the old school to sixty five dollars a year. Leaders wearied of the incessant struggle and longed to exert their united strength in the general cause of medical education. In 1913 old differences were forgotten. The boards of the two institutions met in joint session, amalgamated the two schools and selected a new faculty. Since that time, the Medical College of Virginia, as the consolidated schools were called, has continued to expand and prosper. Now strictly a state institution which is open to both men and women, controlling four hospitals with full time professors in all important departments the college is annually giving instruction to more than eight hundred students.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN their monograph¹ Sicard and Forestier present a comprehensive work on the use of Iodolized oil in the form of Ipiodol in diagnosis and therapy. The greater part of the work is devoted to the application of Ipiodol as a diagnostic medium, relatively little being given as to its action as a therapeutic agent.

The book contains full and comprehensive instructions for the use of Ipiodol as an adjunct to radiology in the exploration of various body cavities. Many excellent illustrations depict typical lesions as revealed by this diagnostic aid. The indications for the use of Ipiodol in the subarachnoid space in the study of medullary compressions are

considered in detail by the authors and the adverse criticisms of the method are answered at length.

The authors do not claim that Ipiodol is an all around substitute for careful clinical examination or for the already known radiological contrast media but they do claim that it reveals many cavities and tracts that were heretofore not possible to photograph by means of the roentgen ray and that it is therefore an invaluable adjunct to clinical examination in many atypical and obscure cases. There is appended a very complete bibliography which is classified according to the chapters of the book, the chapters discussing the different regions treated. Because of this arrangement the book has added value as a handy reference volume in its field.

HALL HAYES

¹THE USE OF LIPIODOL IN DIAGNOSIS AND TREATMENT. CLINICAL AND RADIOLOGICAL SURVEY. By J. A. Sicard and J. Forestier. London: Oxford University Press, 1932.

BOOKS RECEIVED

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THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS. By Winthrop Morgan Phelps, B.S., M.D., M.A., F.A.C.S., and Robert J. H. Kipphoth. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

THE 1932 YEAR BOOK OF RADIOLOGY. DIAGNOSIS. Edited by Charles A. Waters, M.D. THERAPEUTICS. Edited by Ira L. Kaplan, B.Sc., M.D. Chicago: The Year Book Publishers, Inc., 1932.

MODERN ALGEBRA. By William Albert Noyes and W. Albert Noyes, Jr. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

OXFORD MEDICAL PUBLICATIONS. HINTS TO THE YOUNG PRACTITIONER. By G. Francis Smith, M.R.C.S. (Eng.) L.R.C.P. (Lond.) London: Oxford University Press, 1932.

A SYNOPTIC OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch. (Edin.), F.R.C.S. (Eng.) With a Foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.) New York: William Wood and Company, 1932.

LECTURES ON MIDWIFERY AND INFANT CARE, A NEW ZEALAND COURSE. By T. F. Corkhill, M.C., M.D. M.F.C.P. (Ed.) Auckland, Wellington, Christchurch, Dunedin, New Zealand: Collins Somerville Wills Ltd., 1932.

A SHORTER ORTHOPEDIC SURGERY. By R. Brooke M.S., F.R.C.S. New York: William Wood and Company, 1932.

CHIRURGIE DU SYMPATHIQUE PELVIEN EN GYNÉCOLOGIE. By Gaston Cottet. Paris: Masson et Cie, 1932.

THE RHYTHM OF STERILITY AND FERTILITY IN WOMEN. By Leo J. Latz, A.B., B.S. M.D. 3d ed. Chicago: Late Foundation, 1932.

LE RECTUM CANCÉREUX; SON AMPUTATION PAR VOIE ABDOMINO-PÉRIŒALE AVEC ARRÈS-ARRÊT DU COLON AU PÉRIŒRE. RÉSULTATS POST-OPÉRATOIRES. By Dr. Edouard Regard. Préface du Docteur Robert Souppault. Paris: Les Éditions Vêpa, 1932.

NOUVEAUX TRAITS DE PÉDICOLOGIE CHIRURGICALE. Published under the direction of A. Basset, H. Costantini, G. Jeannel, J. Malouin, G. Migonin. Tome VI. UROLOGIE; APPAREIL GÉNITAL DE L'HOMME. By J. Malouin. Paris: G. Doin & Cie, 1932.

LES FRACTURES DES MEMBRES; CLINIQUE ET TRAITEMENT. By René Simon. Paris: G. Doin & Cie, 1932.

PAPERS RELATING TO THE PITUITARY BODY, HYPOTHALAMUS AND PARASYMPATHETIC NERVOUS SYSTEM. By Harvey Cushing. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

CHAPTERS IN AMERICAN GYNECOLOGY. By Herbert Thomas, M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

THE SURGEON'S LIBRARY

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In the early days of the War I was visiting Sir Robert Jones, of Liverpool when the *Lusitania* arrived from New York with John B. Murphy on board. In the afternoon he came to visit Sir Robert, and there I met him for the first time. Jones the acknowledged master of orthopedic surgery was at work. Many of you know him and place him as we do as a superman who has the secret of perpetual youth. The first operation on the list was for the correction of a malunited Pott's fracture, the second was bone grafting for an ununited fracture of the leg. I can still see Murphy keen and intent watching every movement every detail. The cases he was observing were after his own heart. He had written repeatedly on ununited and malunited fractures in the region of the ankle in the sphere of bone grafting he was at his best. I waited for him to speak. I expected to hear something of the methods he himself had advocated but he only gave expression to his unbounded admiration for the operative dexterity of another man. Here was a generous personality quick to appreciate and quick to acknowledge perfection when he saw it. In plain language Murphy had the instincts of a great gentleman.

From Liverpool we traveled together to Leeds. He was communicative and talked freely. It was an experience which I can never forget. He was familiar with and was interested in the work of my colleagues in Ireland. He invited me as his guest to Chicago, an invitation which alas in War time I was unable to accept.

At Leeds we saw Lord Moynihan perform an intestinal anastomosis. Some pardonable egotism might have been expected from such an onlooker as Murphy possessed as he was of an unrivaled knowledge in this branch of surgery. Once again with all sincerity he played the part of the appreciative admirer. He whispered to me that he would have traveled all the way from America to be a witness to the operation which he had just seen performed.

Murphy's unstinted recognition of the work of others would alone have secured him a high place in the esteem and affection of the profession in every land.

It would not be a true picture, if Murphy was portrayed as a man surrounded by surgical intellectuals worshipping at the shrine of his clinic in Chicago. If this were so he would rank above human mortals. He had his critics, he had his enemies. There were those to whom Edmund Burke alluded (writing when he was 18 years of age) as "men who look with an envious eye on talents they can never hope to equal and are willing to bring everything to their own level." Murphy experienced some of this envy and opposition. It is in the nature of things and it can be understood.

It is perhaps a pardonable conceit to couple Murphy's name with those who are associated with the making of the history of Irish medicine. There is a long line of ancestors but after a cursory glance at the ancients it will be more profitable to pass over the intervening centuries and concentrate attention on Murphy's immediate predecessors and contemporaries.

Looking back to the year 37 A.D. almost two thousand years ago we find that the King of Ulster was wounded in the head by a missile and was attended by the great physician Fingen. "Fingen knew from the fumes which rose from a house how many were ill in the house, and every disease which prevailed in the house. This must be true, for it is recorded in the Book of Leinster. The wounded king was stitched with threads of gold because the colour of his hair was the same as gold." These were the days when Celsus (about 30 A.D.) spoke of sutures, ligatures and the dressing of wounds.

Almost eighteen hundred years after Fingen we had in Dublin such figures as Abraham Colles, Dominick Corrigan and R. J. Graves. Abraham Colles goes down to posterity for his accurate description of the fracture which bears his name. It was published in the *Edinburgh Medical and Surgical Journal* in 1814. He had, of course, none of the advantages of radiography; he never saw the fracture during dissection. And yet from clinical observation, in fifteen hundred and twenty-eight words, he gave an original and

accurate description of a complex injury. Subsequent investigation found his observations to be almost faultless. This article, together with the accounts of Colles' law and Colles' fascia will be referred to while literature remains.

When studying medicine in Edinburgh Colles refused to associate with other Irish men on the ground that all people make it a rule to fight and quarrel with their own countrymen rather than with any other. In this respect he did his countrymen an injustice. They are not fastidious in the making of such a choice.

Colles was a man of considerable physical strength and determination. On one occasion he walked from London to Edinburgh a distance of four hundred miles. He earned less than nine pounds the year he started practice in Dublin but like Murphy he sprang for ward and he was elected president of the College of Surgeons in 1802 when he was twenty-eight.

In this same year Sir Dominick Corrigan was born. When thirty years of age Corrigan placed his permanent mark on the history of medicine by his description of 'Inadequacy of the Aortic Valves.' The water hammer pulse and Corrigan's pulse are accepted as synonymous terms. Corrigan had this in common with Murphy—he was the inventor of a button—the two buttons were designed for very different purposes, Corrigan's button was used to fire all and sundry at a time when counterirritation was the order of the day. Sometimes it is used in Dublin even now as an alternative to diathermy and I have seen gratifying results.

The immortal Graves was five years the senior of Corrigan and still more distinguished as a clinical physician in the eyes of those most competent to judge. But as a practitioner Graves did not find the same favor in the public eye. The story is told how when a passenger on board a brig bound from Genoa to Sicily in mountainous seas, he smashed a boat with an axe to prevent the abandonment of the ship by a terrified crew. He repaired the leak in the valves of the foundering ship with leather from his boots and took personal charge of the navigation.

I have purposely mentioned the names of two great physicians and I will mention others, for medicine cannot be divorced from surgery. They and their various handmaids are interdependent without the one the other must totter and fall.

Graves as a manner reminds us of the lines written by an author not free from bias

See one physician like a sculler piles

The patient lingers and by inches dies

But two physicians like a pair of oars

Wast him more swiftly to the Stygian shores

Within my own memory in Dublin there were some outstanding figures in the surgical profession. They have crossed the river and are waiting on the other bank to answer their names to the roll call of the selected few.

Among them was Richard Butcher, William Wheeler (the writer's father) William Stokes, Henry Swansy, Edward Bennett, John Mc Ardle and Edward Taylor.

Butcher was born in 1819, his father was an admiral, one of his brothers was a bishop. His nephews were outstanding politicians in the British House of Commons in recent times. He died in 1891 leaving all his surgical manuscripts and private papers, his library, his instruments and other articles which he prized as a legacy to my father.

Butcher was surgeon to Mercer's Hospital,¹ to which I have been attached for 28 years. I remember him attending me as a child for a broken arm sustained in a struggle with a nurse for the possession of a toy. The records of his surgical work in this hospital occupy many volumes. His manuscript notes in my possession prove the meticulous care with which each surgical problem was approached. They are a record of indefatigable industry and of profound surgical acumen. Later I will mention some of the cases which recently have been dealt with under the same roof.

He was an honorary fellow of the College of Physicians of Philadelphia. He was a man possessed of some vanity and of great muscular strength. Like Samson, his hair was long and hung in carefully tended curls over his neck and shoulders. His biceps, revealed

¹The Dublin Hospital is old of back Handel first played 'The Messiah'.

to onlookers when he was operating was the admiration of medical students. A plaster cast of an arm, typifying perfection in development is to be seen in the anatomical department of Trinity College. Legend has it that it is the arm of Butcher. In America and in the medical schools of Europe he is best known as the inventor of Butcher's saw.

*Some follow letters, others follow law
And some find happiness in War's alarm
But he upholds the glory of the saw
And wields his weapon with titanic arm*

He kept a book (in my possession) of newspaper cuttings. The complimentary references to himself are diligently underlined.

An Irish newspaper dated December 1874 relates how two of the finest athletes in Washington were members of the medical profession, "One of them says the article 'lifts 1,000 pounds with his hands and puts up a dumb-bell of 130 pounds. The other is said to be the strongest man in Washington for his size. He lifts 400 pounds with one hand and suspends 63 pounds at arm's length on his little finger. Underneath this pasted in paragraph is written in Butcher's handwriting—"I have done the same and greater feats."

In July, 1838 when 19 years of age he was studying in London. He conceived the idea of getting over the roofs of the neighboring houses on to the back of the lion which surmounts Northumberland House Gate in the Strand. With the help of a rope he succeeded. "I have placed the picture of Northumberland House in the book," says Butcher "because I performed a great feat on it."

I have accused Butcher of vanity but if time were of no consequence, I could from voluminous documents show that this human frailty was entirely overshadowed by a disposition of simplicity intermingled with understanding and remarkable professional skill.

In about the year 1871, two policemen were shot in the streets of Dublin. One was attended by Butcher in Mercer's Hospital and recovered. The other, a man called Talbot, was operated upon by Stokes and died. The two results were contrasted in newspaper articles. It was publicly suggested that Talbot

was not killed by the bullet but had succumbed to indifferent surgery. "We defy you my lords and gentlemen of the jury," says one paper "in presence of facts so emphatic, and a contrast so instructive, to declare otherwise than that Talbot did not die of the bullet but of the probe, knife, and forceps." The prisoner in the dock was acquitted.

Apparently there was no control over newspaper comments in those days. The medical student and his friends did not heal matters by the publication of verses of which the following are a couple of lines: "Who killed Talbot?" "I," said Bill Stokes, "with me prods and me pokes. I killed him—all but." Stokes was unfairly treated by the press and by the public in this matter. He was a surgeon of high repute, a fine speaker and by his writings added his share to the knowledge of the day.

Stokes the great Dublin physician, was the father of the surgeon to whom reference has just been made. A life long friend of Graves, he became famous in Dublin and abroad for his contribution on the value of the stethoscope, and his description of what is known as the Stokes-Adams syndrome, and Cheyne-Stokes respiration. John Cheyne's account of this type of respiration was published in the *Dublin Hospital Reports* 1818. The description was clarified and exemplified by William Stokes in the *Dublin Quarterly Journal* in 1846. Hippocrates described the exact same type of respiration when he was picturing the condition, so often alluded to in modern medicine as the "typhoid state."

Swanzy was an oculist of high international standing. Bennett lectured in surgery in Trinity College, he was probably the greatest authority on the subject of fractures belonging to the old school. Bennett's fracture of the metacarpal bone of the thumb was described in the *Dublin Journal of Medical Science* in 1882, with the same accuracy as Colles described fracture of the radius a generation before. Later, I will mention his discovery in connection with congenital laryngocele.

McArdle (a friend of Murphy's and to whom Murphy alluded when speaking to me of Ireland) has only recently left us. His early writings *inter alia* on the surgery of the stom-

ach stamp him as a man in the front rank of his time.

It seems but yesterday since E. H. Taylor was writing his book on operative surgery and applied anatomy. He died in his prime after serving as president of the College of Surgeons.

Finally came my own father. He was Butcher's favorite pupil. They were close and intimate friends. He was known by medical students as the Butcher's boy. In 1883 (the Centenary year) he became president of the College of Surgeons. He died at the age of 55 in 1897. In 1886 he described a case of dilatation of the pharynx cured by pharyngotomy the first case of its kind on record. I have in my possession the sections of skulls in the region of the temporal bone on which he based an original description of an operation for mastoid and tympanic disease in 1883. The *American Journal of the Medical Sciences* described the paper as admirable. Recent writers have advocated the adoption of the operation which he designed. In an address entitled 'What has Society Gained by the Progress of Modern Surgery?' almost 50 years ago he speaks with familiarity of intussusception, pylorectomy, renal cysts and aneurysm and of surgery generally as a far grander and nobler science than was that of former years. He denounced Listerism as it was practised at this time. He ridiculed the carbolic spray and the special layers and the particular preparation of the gauze but he was an early convert to antiseptic surgery which he claimed was entirely different from Listerism. He said that those who imagined that they could wash the air of germs by means of a spray and keep them from a wound by gauze and protective were living in darkness. Surgical cleanliness, he declared was the keynote of success. He was an advocate of aseptic surgery before the immortal Lister had seen so far. In these matters he saw eye to eye with Lawson Tait.

Like his great master Butcher he was a man of powerful physique. He was champion light weight boxer as a young man when he served in the army. He married a first cousin of George Bernard Shaw.

In 1882 a land agent was shot in Belmullet, an out of the way village in the West of Ireland 40 miles from the nearest railway station.

The Government at Dublin Castle, under the direction of Mr. Burke the chief secretary took responsibility for the shooting of Carter as proper police protection had been neglected. My father was sent to Belmullet on behalf of the Government to give surgical assistance to the wounded man. In these old days of primitive trains and outside jaunting cars, each journey took almost a day and a half to complete. Several visits were paid and a leg was amputated in 16 seconds! Political feeling was running high the surgeon found it necessary to carry a revolver and to be protected by police. He charged his account to the Government at 125 guineas a visit by previous arrangement. The total bill amounted to £1,147 18 0 including 50 guineas for the operation. The Government repudiated liability and there was an action at law. During the evidence Butcher swore as an expert that if he had been employed he would have doubled the fees.

In those days there was not the fraternal feeling which rules now between the surgeons of one city and those of another. There was considerable rivalry between the surgeons of London and of Dublin. When reference was made by Counsel for the Crown to the more moderate charges of first class London surgeons Butcher full of fight, delighted the Irish Jury by suggesting that such men did not exist. The case was withdrawn after a graceful statement by the attorney general and the fees were paid in full.

In mentioning some of those who did credit to the Irish school of medicine, I have not lost sight of Murphy. It was the environment of the ever progressive America which brought this surgical colossus to the heights he attained. The lesser but still great achievements of his kinsmen in Ireland may be attributed in a measure to the fact that the same blood flowed through the veins of all.

In an address by Dr. W. R. Bett of London, entitled *Chlo* by the Bedside, dedicated to Sir Humphrey Rolleston "because he liked it," it is pointed out that the elaborate edifice of modern medicine has not sprung up from the ground like a mushroom in the night. Each generation has put its hand to the task, has toiled and labored to complete its superstruc-

ture Its bricks represent the years its floors the centuries

More bricks and more floors will be added by future Murphys throughout the years and centuries that are to come

The exploration goes on The explorers wonder as of old what comes next and what part they are to play In their dreams they see Valhalla The spirits of their surgical forefathers are beckoning them to the land where dreams come true The work will continue when we have shuffled off this mortal coil

And only the Master shall praise us and only the Master shall blame

And no one shall work for money and no one shall work for fame

But each for the joy of the working and each in his separate star

Shall draw the thing as he sees it for the God of Things as they are

Those who have paid homage to Murphy at these great assemblies in past years have alluded specifically to some branch of his work, and some have recorded their own experiences in surgery in order to emphasize their indebtedness to his teaching

The scope of Murphy's writings is so wide that each successive speaker has been able to find a path which covers new ground By referring to individual and detached cases I will endeavor in some small measure to follow this precedent.

I must confess that it is difficult to obtain the end results of any large series in Ireland In the first place, we have a multiplicity of small hospitals in Dublin each completely detached from the other In the second place, our Gaelic temperament is such that patients consider it is ungenerous to admit of any suffering whatever, when inquiry is made for the purpose of statistics to be published abroad

Some years ago I wrote to a country practitioner to ascertain the end results of cases of gastrectomy I explained to him that the information was needed to compare the results from Dublin, with those of other countries, at an annual meeting of the British Medical Association His reply dictated more by patriotism than accuracy indicated that the

patients were well in every respect when last he saw them but that in some mysterious manner they had disappeared one by one from the district He added that as the country was disturbed they must have been shot, "or died from other natural causes"

SURGERY OF THE BLOOD VESSELS

Pupils in the Hunterian School shared in the enthusiasm of their teachers and the surgery of the blood vessels became a favorite subject of research and of practice during the opening years of the last century

The teaching of John Hunter was carried across the Atlantic by Wright Post to New York by Physick to Philadelphia, by Gibson to Baltimore and by Warren to Boston One surgeon alone—Valentine Mott ligatured the common carotid forty three times the external carotid once the first part of the subclavian once and the third part of the subclavian four times It is no matter of surprise says D'Arcy Power that the tradition of the surgery of the blood vessels is stronger in the United States than it is in this country Professor Rudolph Matas has nobly maintained the tradition at New Orleans by his reparative treatment of aneurism which is based upon experimental surgery in the true Hunterian spirit

Murphy was at home in the realm of vascular surgery In the year 1896, he performed the first recorded end-to-end suture of a divided artery His description of how he approached a false aneurism of the axillary artery by division of the clavicle and ligature of the subclavian artery is a noteworthy contribution to his surgical records

He paints a dramatic picture of a case of aneurism of the internal carotid artery mistaken for a tonsillar abscess Listen to him speaking "First a few clots of blood slowly wriggled their way out, and a little faster a few more Then came the rush of the arterial current with the full force of the spurting carotid The patient strangling in his own blood struggled wildly, and his friend ran away in a panic, an abject deserter Before Dr Lee could gain control of the patient the latter had bled to death and the office was like

a shambles from the struggle. Then comes the mention of thirteen different forms of treatment for aneurism and finally the statement that no surgeon should start the active practice of surgery until he has done a considerable amount of experimental work on the arteries and veins of dogs. After complimentary references to the operation of Matas he concludes an interesting discourse with the remarks "We Americans are little inclined to be Chauvinists. We are pretty apt to take what is good where we find it and if we owe a great debt to foreign medicine, it is because we have had the breadth of vision and unbiased minds necessary to profit from it.

Ligature of the innominate artery for right subclavian aneurism. In May last I ligatured the innominate artery for aneurism of the subclavian artery involving the first and second stage. The patient was wounded in 1915 pieces of shrapnel were shown by X rays, scattered in the region of the right shoulder joint, and portion of a bullet could be felt to the right of the suprasternal notch under the insertion of the sternomastoid muscle. The wall of the artery was apparently injured but the aneurism did not become evident until 1928 13 years after the wound. It steadily increased in size until the swelling above the clavicle reached the size of a duck's egg. The right recurrent laryngeal nerve was paralyzed. The radial pulse was not affected the blood pressure was the same on both sides. The X rays demonstrated some calcification within the sac. The Wassermann reaction was negative.

In some respects this tumor was not typical of aneurism there was no bruit expandible pulsation could not be detected there was no difference in the carotid or radial pulses when compared with those of the other side.

An operation was designed to ligature the subclavian artery behind the scalenus anticus muscle at the commencement of the second stage. The middle portion of the clavicle was turned downward on the chest with its pectoral attachments. The aneurism was laid bare and the bullet was removed. The external and internal jugular veins were found obstructed and distended. The supraclavicular and transversalis colli arteries spread transversely across the upper portion of the tumor

The scalenus anticus muscle had disappeared and the phrenic nerve was not located. It was soon seen that the sac extended to the bifurcation of the innominate artery and that ligature of the subclavian vessel was impossible. It was obvious that without further removal of bone the innominate artery could not be exposed behind the sternoclavicular articulation without the rough handling of the aneurism, which had led to disaster in many recorded cases. With chisel and mallet, the inner end of the clavicle together with the right half of the manubrium sterni (leaving the sternoclavicular joint intact) were separated and retracted upward and to the left. The innominate artery was now visualized in its entire length. The innominate veins were not seen the pleura caused no embarrassment, the nerves remained hidden.

Two ligatures of No. 2 chromicized catgut were passed around the artery distal to the thyroidea ima branch. They were gradually tightened care being taken not to cut through the inner coats of the vessel. Pulsation at once ceased in the aneurism and the radial pulse disappeared. Proximal to the ligature each pulsation appeared like a sledge-hammer blow upon the occluded portion. It looked as if the assault could not be resisted. For this reason, an additional single ligature of catgut was placed around the artery near its origin from the aorta. The thyroidea ima was ligatured with fine silk. The divided portions of the sternum and clavicle were replaced in position and held by catgut passed through drill holes. Recovery was uneventful but for some downward displacement of the divided portion of the clavicle.¹ In 3 days the radial pulse reappeared and within a week it was full and synchronous with the pulse on the opposite side.

The experience of this case suggests that ligature of the innominate artery is not a difficult operation provided the old inadequate methods of approach are abandoned. Six weeks after ligature some slight pulsation could be felt in the aneurism, but otherwise the cure appeared complete.

¹Four months after operation, the aneurism had completely disappeared. Very slight pulsation could be felt at the site of the original tumor.

Up to and including the year 1922, according to Ballance, there had been 57 ligatures of the innominate artery with 19 recoveries.¹

A case of ligature of the innominate artery was exhibited by Mr Coppinger of the Mater Hospital, Dublin at the Section of Surgery of the Royal Academy of Medicine in Ireland, on February 24 1893. The record states that this was the first successful case of ligature of the innominate artery ever exhibited at any medical society in Europe.

The ideal operation for subclavian aneurism is excision of the sac after proximal and distal ligation. This has been successfully performed by Moynihan² by Halsted³ who removed with the aneurism a portion of the subclavio-axillary vein and also by Braithwaite.⁴ The possibility of ligaturing either the first or second portion of the artery is a condition precedent to excision. Both portions were involved in the sac in the case I have just mentioned.

In a volume⁵ on the works of Colles by Robert McDonnell, who was president of the Royal College of Surgeons in Ireland in 1877, the operation of tying the subclavian artery is admirably described. Colles attempted more than once to ligature the first stage of the artery, a far more difficult procedure than ligation of the innominate. He thought that ligation of the first stage on the left side was almost an impossibility, but A. K. Henry⁶ has shown that this operation is greatly simplified by an approach from behind.

Thoracic aneurism treated by wiring. Some years ago (1928) an ex soldier was admitted to hospital with an aneurism protruding through the chest wall to the right of the sternum below the clavicle. It appeared on the point of rupture. The heart and aortic arch were shown in the X-ray films to be greatly enlarged. It was thought that rupture might be delayed by consolidation if a wisp of Colt's wire was introduced. A month later the end of the wisp at the point where the wires are joined, became superficial and later ulcerated



Fig. 1. From a snapshot picture of Dr. John B. Murphy and Mrs. Murphy taken in the garden of Sir Robert Jones, Liverpool, in 1915.

through the skin. The junction was nipped with pliers and all the strands of wire were removed from the aneurism. Three months after operation the patient died from gradual leakage into the mediastinum and pleural cavity? No postmortem was obtained.

Abdominal aortic aneurism. America holds the world's record for thoracic aneurism treated by wiring and electrolysis. Colt states that Dublin holds the record for abdominal aneurism treated by wiring alone.⁷ In August 1910, a patient with a large abdominal aneurism in the region of the coeliac axis was treated in Mercer's Hospital by the introduction of a cage of Colt's wires (150 inches) into the sac. He died suddenly on March 31, 1928, approximately 18 years after operation. The doctor in attendance reported that there was no abnormality of pulse or temperature or signs of internal hæmorrhage when he saw him just before death, but no postmortem was obtained.

In a second similar case, a wisp of 105 inches of wire was introduced into the sac of

¹Brit. J. Surg. ix, 438.
²Ann. Surg., 494, xxviii.
³Bull. Johns Hopkins Hosp. 89, July-August.
⁴Brit. J. Surg., vii, p. 60.
⁵London. The New Sydeham Society. 28.
⁶Brit. J. Surg., x, 167.

⁷These cases are described by kind permission of the Director General Ministry of Pensions.
 Brit. J. Surg. xiii, 113.



Fig. 2. R. G. Butcher of Dublin, 510-80. President Royal College of Surgeons of Ireland, 1906-56. The cartoon bore the inscription "A wise Saw—What! Butcher wouldst thou have thy pound."



Fig. 3. Cartoon of Butcher with press references. Note the coat of arms of the cartoonist. "I come, I sawed, I conquered."

the aneurism. After operation the man was passed as sound for service during the War as a stoker on a patrol trawler in the Naval Reserve. He died of leakage from a secondary dilatation of the aorta below the aneurism while thus serving, 4 years and 8 months after operation. At postmortem examination the aneurism was found completely consolidated. It was about the size of a full time fetal head. The wires had expanded uniformly. The specimen is preserved in the Surgical Museum of Trinity College.¹

I am indebted to Surgeon H. E. King Fretz, R.N. for the following notes on postmortem examination. Case 2.

"The patient, aged 37 a stoker R.N.R. on one of the patrol trawlers, was admitted into the Naval Hospital on March 12 1916. He complained of vomiting and severe shooting pain in the right lumbar region simulating renal colic. There was tenderness in the region of the appendix and pain on deep inspiration. He was sweating freely and in a state of collapse. There was a large pulsating tumour which practically occupied the whole of his

epigastric region, apparently an aneurism of the abdominal aorta. His temperature was 99° F pulse 120, full and regular systolic pressure 240 mm., diastolic pressure 120 mm. His urine showed a heavy deposit of urates and a trace of albumin. There was an excellent scar to the left of the mid-line 3 inches long the result of operation five years ago. A systolic bruit could be heard over the swelling propagated all over the abdomen and down both femoral arteries. There was a marked diastolic sound in the mitral area and a very accentuated second sound in the aorta. Seven days after admission he died. The swelling continued to pulsate long after respirations had ceased.

"At the autopsy it was found that there was a small leak, the hemorrhage penetrated between the layers of the mesentery separated them widely apart, and surrounded a large portion of the small intestine. The right kidney was pushed forward. Both kidneys and spleen were normal in size, the right kidney having small granular patches on the surface. The heart was much enlarged. Now for the aneurism, I am not exaggerating when I say that the clot formed in it is as hard as a rock, the aneurism itself is about the size of a full term foetus head. It appears to me as if there is a secondary dilatation of the aorta below the main swelling and that is where the trouble arose.



Fig 4 Northumberland House Strand, London. Butcher, in July 1838, describes how under perilous circumstances he succeeded, with the aid of a rope in climbing on the back of the lion

I am also indebted to Surgeon King Fretz for the specimen which is illustrated in Fig 1 and for the X-ray photograph showing the wire *in situ* (Fig 2)

The abdominal aorta was first ligated by Sir Astley Cooper. In 12 cases recorded subsequently, the mortality was 100 per cent. Nevertheless ligation below the renal vessels has been followed by success. Brookes¹ described and illustrated a case in which the patient died of intestinal obstruction 3 months after successful ligation. The prognosis of abdominal aneurism without operation is unfavorable. The duration of the condition is said to vary from 3 months to 3 years.

Aneurism of the popliteal artery How the more modern conception of the surgery of the blood vessels comes to our assistance may be illustrated by a case of popliteal aneurism in a man aged 62 years. The aneurism was the result of a slight injury and had reached the size of a cocoanut. It had extended upward from the popliteal space to the opening in the adductor magnus. The patient was a bad surgical risk. He was fat and short necked. His heart was fibrillating, his systolic blood pressure was 220, his pulse rate 140. His foot was cold and

gangrene was impending. The old operation of ligation of the femoral artery would almost certainly have been followed by gangrene. An extensive operation on the sac or amputation in all probability would have been followed by death. A complete cure with restoration of the circulation in the limb followed resection of 1 inch of the artery in Hunter's canal and ligation of the femoral vein.²

Resection of the artery is a radical form of sympathectomy and in this case produced increased heat and blushing of the foot. The sheath of the artery above and below the ligatures was injected with alcohol as recommended by Sampson Handley to ensure against transitory vasoconstriction.

The advisability of ligaturing both artery and vein or the vein alone, when there is a dangerous diminution of the blood supply to a limb has only been recognized since the War. This recognition, reinforced by a better understanding of the surgery of the sympathetic nerves, has saved many limbs in recent years.

THE SYMPATHETIC NERVOUS SYSTEM

The assaults brought about by an unbalanced sympathetic nervous system have been

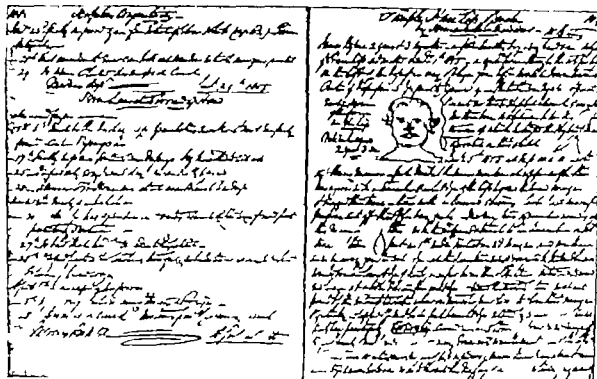


Fig. 5 Page from one of Butcher's voluminous case books, describing his operation for hare-lip.

countered by the surgeon in many fields. Pylorospasm and megacolon can be cured or relieved spasm of the vesical sphincter causing urinary retention is coming under control pelvic pain *per se* disappears under the magic wand of sympathectomy.

Raynaud's disease can now be conquered and certain forms of polyarthritis have yielded to sympathetic resection.

HIRSCHSPRUNG'S DISEASE

This is a rare condition. I have had 2 cases under my care in 10 years. The colon may contain as much as 47 pounds of feces, the circumference of the bowel may reach over 3½ feet. The bowels may act only once in 2 or 3 weeks and in some cases several months have elapsed without an evacuation. Until the discovery of the rôle of the sympathetic in this condition physicians ordered surgical treatment, surgeons recommended a medical regimen.¹ In one third of the cases the sigmoid flexure alone is involved and excellent results

can be obtained by the simple operation of removal of the left sympathetic chain by a trans-pentoneal operation. The removal includes the second, third and fourth ganglia.

In my second case the limited operation proposed by Rankin and Learmouth was performed (February 1931). The child was aged 2 years. The pelvic colon when the abdomen was opened had the appearance and consistency of a small motor car tire.

In this case there was one unusual feature. The pelvic colon was not dilated for 2 or 3 inches above the pelvi-rectal sphincter and the rectum was normal. X-ray photographs taken before operation showed an enormous loop of descending colon. The barium meal was visible a week after ingestion, notwithstanding repeated washing out of the colon. The barium enema also revealed an enormous colon, five or six times the normal diameter. The ascending colon was not dilated, and the transverse only moderately so.

The posterior pentoneum was divided from the promontory of the sacrum to the origin of the inferior mesenteric artery. The presacral nerve and its branches in the infant were not easily defined, but communicating filaments from the second, third,



Fig. 6. Subclavian aneurism showing the bullet and calcification in the sac.

and fourth sympathetic ganglia were divided and the area cleared of loose connective tissue. The inferior mesenteric artery near its origin was similarly denuded but no very definite ganglia were found. The operation was rendered more difficult

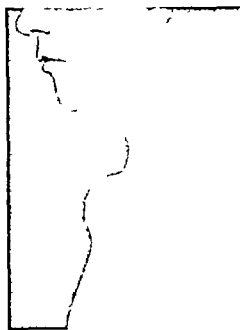


Fig. 8. Thoracic aneurism from which wires were removed a month after introduction.

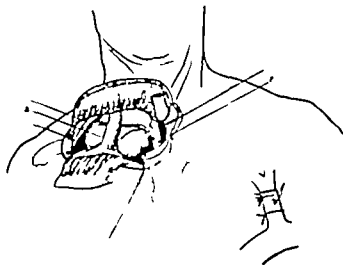


Fig. 7. Ligation of the innominate artery. The operation was planned at first for ligation of the subclavian artery but was modified later to ligation of the innominate artery. I Transversalis coli; B external jugular vein; C supra scapular; D portion of sternum and clavicle retracted; F innominate artery. Inset shows ligatures proximal and distal to the thyroidea ima branch.

by the attachment of the mesocolon to the right of the middle line.

We had some difficulty in deciding whether we were dealing with tiny lymphatic vessels and glands instead of nerve fibers and ganglia in the course of the operation. In an infant I am not sure that frank exposure of the lumbar sympathetic chain on the left side and division of the trunk above the second and below the fourth ganglion would not



Fig. 9. Side view of aneurism. The line marks the point of rupture. (One half natural size.)



Fig. 10. Postmortem roentgenogram of abdominal aneurism 4 years and 8 months after operation. Colt's wires re seen in the sac.

be the more satisfactory operation ramisection being performed at the same time.

The boy's constipation was completely relieved by the operation, and this relief has continued. After operation a full sized sigmoidoscope was passed through the pelvi-rectal sphincter on a few occasions, the colon being emptied by means of an irrigating tube. Two months after operation a barium meal and enema demonstrated the pelvic loop of colon still dilated, but greatly reduced in diameter. The transverse colon was also considerably reduced. Seven months after operation dilatation was still present, but there was slight further improvement. The umbilical girth at the time of operation was $23\frac{1}{4}$ inches. Five days later it was $21\frac{1}{4}$ inches.

KIDNEYS AND PROSTATE

It has been pointed out that Murphy in his lectures on the surgery of the urinary tract laid great emphasis on the significance of back pressure in cases of prostatic obstruction.

Success depends on the relief of this back pressure and it is an accepted fact that this relief must be gradual. Back pressure renal insufficiency, cardiovascular changes and uræmia, go side by side as time advances with prostatic enlargement. It is traditional that

sudden decompression either by uncontrolled cystotomy or by primary prostatectomy is followed by a recoil carrying a high mortality. The engorgement of the kidneys on sudden release of pressure is not surprising when we remember that the whole of the blood of the body passes through the kidney every few minutes. The other side of the picture shows the reparative phenomena which follow gradual decompression. Renal cells, like hepatic cells, and myocardial cells, have a definite power of regeneration if the causes producing degeneration are removed. In old standing cases, some of the kidney is irreparably damaged, some is damaged but is capable of regeneration and there is probably a residue in most cases which has not yet become embarrassed.

In cases of overdilatation of the bladder the path of safety is not the inserting of a catheter and the withdrawal of small amounts



Fig. 11. Hirschsprung's disease. Condition of the descending colon before operation. Note the undilated loop of pelvic colon below.

of urine every few hours. A few ounces (100 cubic centimeters) of urine, withdrawn from a distended bladder, may induce renal and circulatory shock.

For many years in Mercer's Hospital we have gradually decompressed distended bladders by allowing the urine to flow drop by drop by means of a reversed Murphy drip apparatus attached to an in-dwelling catheter. If this apparatus is not at hand a rubber catheter is passed. It is clamped or plugged at the end to prevent urine escaping. A hypodermic needle is inserted through the rubber wall of the catheter, and through this needle the urine drips slowly until danger is passed. An ureteral catheter passed into the bladder acts in the same manner.

The necessity for gradual decompression is not confined to the urinary tract. The same problem arises when we are dealing with medical problems such as high blood pressure.



Fig. 13. Child aged 2 years six months after conservative sympathectomy for Hirschsprung's disease. The constipation is cured, the distention is reduced (girth of abdomen at operation 23½ inches now 21½ inches) but persists.



Fig. 12. Hirschsprung's disease. Condition of colon 6 months after operation.

It confronts us when there is back pressure on the liver, it is a factor in cases of ascites and intestinal obstruction. It faces us again in cerebrospinal lesions in acute empyema, in hydramnios, hæmatocolpos and glaucoma. Thus medicine, surgery, gynecology, and ophthalmology are all concerned in the fatal significance of a severe recoil following sudden decompression.

The general problem so far as treatment is concerned might, I think, be expressed as follows, in the terms of a law. *When an organ or system is suffering directly from pressure effects or indirectly from back pressure the greater the pressure the more gradual should be its relief.*¹ Hippocrates indeed drew attention to this fundamental consideration in the following aphorism given to me by Dr. T. P. C. Kirkpatrick:

δαρσοι λιμνιοι η υδροπικιοι τεμνονται η καλοται
εκπύοντες του πύου και το υδατος αθρόου πάντως
ἀπολλύονται.

"Purulent or hydropsical cases who are lanced or cauterized, water and pus flowing out together, perish completely." (Aphorism of Hippocrates Sect vi, No 27.)

¹Wheeler. *Canada M. Ass. J.* 1931 II. 8.



Fig. 14. Recurrent prostate. The prostate was removed with "cure" of patient. Symptoms recurred 12 years after operation. Examination revealed advanced obstruction from a regrowth of the gland. It was removed a second time by enucleation and dissection. The illustration shows the second prostate.

RECURRENT PROSTATE

Recently I had under my care a man aged about 75 suffering from advanced uremia the result of prostatic enlargement. The prostate had been removed 12 years previously by Sir Conway Dwyer in the Richmond Hospital. For 12 years after operation he was completely relieved, but after this period the old signs and symptoms of prostatic enlargement gradually

recurred until finally the residual urine was at the maximum and by chemical tests renal destruction was almost complete. A greatly enlarged prostate could be felt per rectum.

This was a case of recurrence of simple enlargement of the prostate. The condition is referred to by Sir John Thompson-Walker in the Lettsomian Lectures delivered before the Medical Society of London.¹ This writer draws attention to a number of cases in which the prostate appears to have been reconstructed after prostatectomy.

In the case I have just mentioned gradual decompression and subsequent drainage for 6 months secured a sufficient return of renal function to permit a second prostatectomy. This was accomplished partly by enucleation and partly by dissection. The final recovery was complete.

SOLITARY CYST OF THE KIDNEY

A cyst surrounded by renal substance was removed from the upper pole of the right kidney of a woman aged 57 years, in September 1931. Painless hematuria and the presence of a smooth, painless enlargement of a right mobile kidney were the outstanding clinical features. Pyelography revealed the upper calyces occluded and deformed, and slight hydronephrosis on the left side. Biochemical



Fig. 5. Solitary cyst removed from the upper part of the kidney with surrounding renal parenchyma.

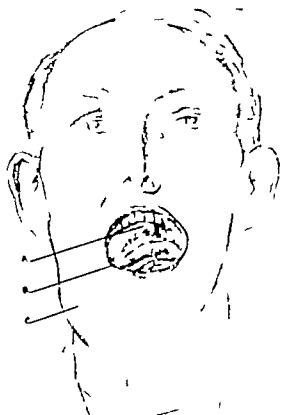


Fig. 16. Congenital laryngocele. *A* Air containing protrusion on the dorsum of the tongue, *B* tip of tongue deviated but could not be protruded, *C* communicating air sac in the submaxillary region. Illustration was made from the patient before death.

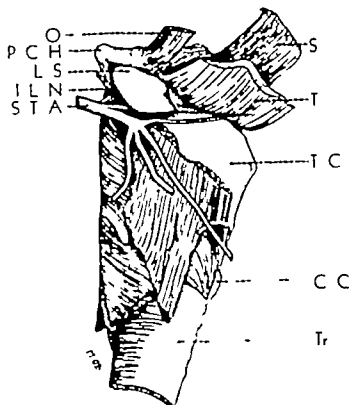


Fig. 1. Congenital protrusion of a laryngeal pouch. Drawing from a specimen in Trinity College Dublin, by kind permission of Professor A. F. Dixon.

investigation showed a high blood urea 72 milligrams per cent, the urea concentration test revealed an excretion of 1.5 per cent urea 3 hours after the meal.

The cyst was about the size of a tangerine orange. On exposure, the kidney was found quite normal but for the upper pole which was involved in the cyst. It was removed by a wedge-shaped incision into the kidney substance. The cut renal surfaces were brought together by interrupted Halsted's stitches. The stitches were prevented from cutting through by the interposition of portions of detached muscle after the manner recommended by Walters. Recovery was uneventful.

Solitary cysts of the kidney are rare. Fullerton¹ says that up to the time of writing (1926) only 99 cases had been reported.

LARYNGOCELE

Murphy excelled in the realm of diagnosis. He could separate the essential from the non

essential factors with great rapidity and in a short time what appeared to be a complex tangle of contradictory signs and symptoms was straightened out and made simple.

The case to which I now draw your attention puzzled us considerably but by applying the inductive methods of reasoning adopted by Murphy its nature was finally made clear.

The patient was a man aged 24 years, who suffered all his life from a painless bulge or swelling in the right submaxillary region. This swelling was tympanitic and under pressure disappeared. The swelling moved and protruded with deglutition or coughing. The right side of the tongue and floor of the mouth were enlarged. On the posterior third of the dorsum of the tongue on the right side there was a soft conical projection about the size of a small lump of sugar. The tongue could not be protruded. Any attempt to do so resulted in deviation of the entire organ to the right side. Speaking was difficult. It was owing to the fact that his friends could not understand what he said that he came to hospital to seek advice. The swelling on the tongue and the swelling in the submaxillary region were connected. If the one was pressed upon, the other enlarged. It was obvious that the swellings were not solid, nor did they contain fluid. The introduction of a hypodermic needle into the protrusion on the tongue gave no information. After the injection



Fig. 18. Laryngocoele, lateral view. The protrusion on the tongue was injected with 10 cubic centimeters of lipiodol. Note the narrow connection between the lingual and submaxillary portions.

of lipiodol through the needle. X-ray photographs confirmed the fact that the tongue swelling and the submaxillary swelling were connected.

At this stage, the true condition was not realized. With a view to operative exploration, the patient was given colonic ether. He died suddenly before anesthesia was produced.

On searching the literature the first clue to the nature of this case was obtained from a paper on malformation of the larynx by E. H. Bennett published in the *Dublin Quarterly Journal of Medical Science* vol. 40 1865. Bennett was the first to discover a human larynx in which there existed fully formed laryngeal pouches which are normally found in a high state of development in some of the higher apes.

Bennett was dissecting in the region of the thyroid cartilage in Trinity College. His attention was arrested by a cystic structure which he opened accidentally on one side. A probe passed downward through the opening into the larynx. At first he thought that the condition was the result of disease but he found a similar sac on the opposite side. Further investigation showed that the pouch occupied nearly all the space which is covered by the thin lateral portion of the thyrohyoid membrane. The lower border of the protrusion rested on the superior laryngeal vessels and nerve and superiorly was in contact with the under surface of the great horn of the hyoid bone. On examining the interior of the larynx the probe passed through the sac from without, beneath the anterior part of the false vocal



Fig. 19. Laryngocoele, anteroposterior view. Note the trickle of lipiodol toward the lateral wall of the larynx.

cords. It entered the ventricle of the larynx by an opening of oval shape, about three-fifths of an inch in length. The opening corresponded to the sinus of Morgagni.

Professor A. F. Dixon, professor of anatomy in the University of Dublin, kindly showed me another specimen from which the drawing (Fig. 17) has been made.

There is little doubt that the patient to whom I have referred was suffering from this congenital deformity. The appendix of the laryngeal ventricle on the right side had extended through the thyrohyoid membrane in an upward direction behind the body of the hyoid bone to the floor of the glosso-epiglottic fossa.

There is no mention in surgical literature of the extension of these extra laryngeal pouches into the tongue. In the apes they extend down the neck, often as far as the clavicle or



Fig. 20 Multiple lesions. Patient's breast removed for cancer 5 years ago. Thought to be suffering from metastasis. Investigation revealed bilateral renal calculi and simple ulcer of the lesser curvature of the stomach; gastrectomy; recovery.

between the two heads of the great pectoral muscle into the axilla. They attain a very large size.

Von Bergman¹ mentions laryngocele and congenital air cysts in connection with swellings of the neck. He and other German writers refer to the danger of sudden death from suffocation when the sac becomes overdistended.

The fact that the lipiodol did not enter the larynx in the case under review may be explained on the hypothesis that the interior opening was either very minute or of a valvular nature.

In his *Anatomy*,² Quain states that the blind end of the appendix sometimes passes upward, lateral to the aryepiglottic fold and behind the body of the hyoid bone, so as to lie close to the floor of the glosso-epiglottic fossa. In this volume reference is made to Slavunas who collected reports of 10 cases of congenital



Fig. 21 Same case as in Figure 20, showing the large branching renal calculi.

laryngocele. Two were bilateral, 4 were unilateral, and 4 were bilateral but with a larger sac on one side.

Andre Forster, professor of medicine in Strasbourg, gives a very full illustrated account of the laryngeal sac in apes.³

MULTIPLE LESIONS

It is like pushing an open door to mention to an assembly such as this the necessity for complete and thorough examinations in all cases, but diagnostic endeavor in small surgical centers has a tendency to become concentrated and focused on one prominent lesion. If a patient is found after examination to be suffering say from duodenal ulcer, it is forgotten that gastric ulcers may also be present and the case further complicated by disease of the pelvic organs, the kidneys, or the gall bladder.

I have been struck with the number of patients who come for operation suffering from cholelithiasis who were found to have a midline scar below the umbilicus for the correction of what was believed to be some uterine or ovarian disease. This scar has so frequently been in evidence (in fat women who have borne children) that many students in Dublin regard it as supporting evidence of the diagnosis of biliary stones.



Fig. 22



Fig. 23

Fig. 24

Fig. 22. Pendergast K. Wounded 1918. The right arm hangs from the trunk by a pedicle containing the vessels and nerves. The skin, deltoid muscle, and upper end of the humerus were blown away.

Fig. 23. Roentgenogram taken immediately after operation. A 4 inches of the graft is intramedullary; the upper portion is in contact with the glenoid cavity, the coracoid, and the acromion.

Fig. 24. Patient 14 months after operation holding a vessel 5½ pounds in weight at arm's length for a time exposure photograph.

Fig. 25. Result 5 years after operation. Note the medullary cavity in the graft and firm ankylosis with scrofula.

(Figs. 22-25 from Brit. J. Surg., 1921, 34.)

An interesting case with multiple abdominal lesions was admitted to Mercer's Hospital in October 1931.

She was aged 56. Five years previously her breast had been removed for carcinoma. She had lost weight, she was anemic, and she suffered from constant pain in her upper abdomen. Metastatic growth was diagnosed without full investigation in the first instance. X-ray photographs showed a chronic penetrating ulcer in the lesser curvature of the stomach. Cystoscopy revealed that the urethral orifices were normal but that pus was flowing in large quantity from the right side. The blood urea was high. The urea concentration test after 5 hours gave a 1 per cent excretion. Further X-ray photographs demonstrated large branching calculi in both kidneys. The middle portion of the stomach was removed under gas oxygen and local anesthesia. The ulcer was found to be non-malignant and the patient made a rapid recovery. No doubt uremia will eventually supervene, but for the moment her pain is gone, and the dread of cancer has been stilled.

Finally I will mention 2 cases: one of bone grafting to replace the upper end of the humerus and the other arthroplasty for ankylosis of both knees. The operations were performed exactly as Murphy dictated and the results



Fig. 25



Fig. 26. Right knee joint ankylosed in extension.

Fig. 27. Left knee joint ankylosed in flexion.

obtained were entirely due to the doctrines he preached

Figure 22 shows a soldier aged 25 who was wounded toward the end of the War. The right shoulder below the acromion process was carried away *en masse*—skin, muscles and bone. Only a pedicle remained on the inner side carrying the main vessels and nerves by which the arm hung helplessly to his side. All scar tissue was cleared away and the upper end of the bone was freshened. A bone-graft 9 inches long taken from the tibia was driven for 4 inches into the medullary cavity. The upper portion was placed in contact with the glenoid cavity. Three months



Fig. 30. Snapshot of child walking, right knee.

Fig. 31. Snapshot of child walking, left knee.

(Figs. 26-31 from Brit. J. Surg. 1921, ix, 34.)

later the graft had thickened but there was loss of density in the picture owing to the destructive powers of the osteoclasts being more apparent in the X rays than the regenerative powers of the osteoblasts. Six months after operation firm bony union was shown at the upper end of the new humerus. The intramedullary portion of the graft has become partially absorbed. Nine months after operation strong new bone had replaced the slender original graft. Fourteen months after operation



Fig. 28. Amount of voluntary flexion in left knee joint 2 years after operation. Note the patella "turned turtle."

Fig. 29. Amount of voluntary flexion in right knee joint 28 months after operation.

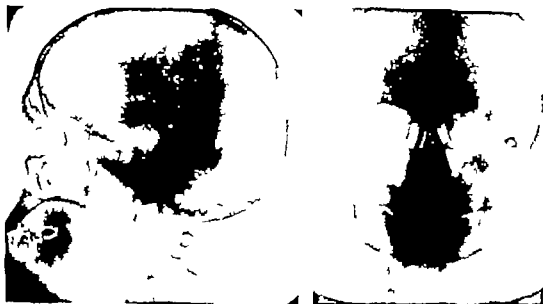


Fig. 32 Lateral and anteroposterior views of patient with bullet in the association area of the brain

although movements of the shoulder were limited, the strength of the arm left nothing to be desired.¹

After five years an X-ray photograph shows the humerus completely reformed (Fig. 33)

ARTHROPLASTY

The accompanying illustrations (Figs. 26-31) show the result of Murphy's arthroplasty in the case of a girl aged 11 years operated upon in September 1919.²

FOREIGN BODY IN THE BRAIN

The following case is mentioned because the history given by the patient is picturesque and because it is unusual for a bullet to enter the brain without the patient knowing that he had been severely injured

A patient aged 21 was wounded in the head in May 1921 while engaged in street fighting in Dublin. He received what he believed then to be a small scalp wound to the right and above the occipital protuberance. He was dressed but not detained in the hospital. No X-ray was taken. He noticed at the time of his wound sounds of music in his ears as if there was a band with drums in close proximity. A fortnight later he was smoking a cigarette when a black dot appeared in his right lateral field of vision. The speck moved medially, growing larger and becoming bright until it appeared as a blinding light in the center of his visual field.

At this stage he became totally blind. He never lost consciousness, but his memory was stimulated and distorted. He imagined he saw men firing at him, while he was surrounded by comrades. Head ache and vomiting supervened. These aural attacks lasted about 30 minutes and recurred once or twice a month for 4 years. In the intervals he was well, and led an energetic life, but the re-appearance of the black spot when least expected like the ghost of Hamlet left him morbid and alarmed.

Clinical examinations were entirely negative there was no paralysis, motor or sensory, no alterations in the reflexes, and both fundi were normal.

X-ray examinations disclosed that the nickel case of part of a conical bullet was lying in the base of the brain just behind the petrous portion of the temporal bone at the level of the eminence in the superior semi-circular canal. To approach the bullet in a direct line it would have been necessary to open the skull behind the vertical line dividing the mastoid into equal parts. The direct route would have led through the sigmoid portion of the lateral sinus and some of the posterior branches of the middle meningeal artery.

Operation December 10, 1925. The skull was opened at a level above the location of the bullet, and when the meninges were divided, a finger was passed under the temporal lobe in front of the cerebellum. After some difficulty a feeling of resistance was detected with the finger, and with the latter *in situ* a forceps was pushed through the temporal lobe from above. A mass about the size of an olive was located and was enucleated. There was a line of cleavage between the mass and the brain substance. On removal the tumor proved

¹Wheeler Brit. J. Surg. 92 12, No. 34.

²Wheeler Brit. J. Surg. 92 12, No. 34.

to be composed of fibrous tissue encapsulating the conical point of the bullet. Before it could be extracted it became necessary to nibble away bone toward the base of the skull. The sigmoid portion of the lateral sinus was wounded but the control of bleeding was not difficult.

During the removal, some brain matter on the lateral surface of the temporal lobe was injured and removed. In bulk the brain matter sacrificed was about the size of the tumor.

The after history was uneventful. A month after the operation the patient appeared quite well. He had no recurrence of his previous attacks.

Before operation a model of a brain was placed in a skull and with the aid of the X rays it was possible to map out the exact position of the foreign body encapsulated in the fibrous mass. It lay underneath the junction of the temporal and occipital lobes. The area involved was the association area which lies between the visual area behind and the portion of the brain concerned with hearing in front.

It was interesting to correlate these findings with the clinical history given by the patient. There were just three points in the history: (1) The sounds of hand music on the day he was wounded. (2) The distorted visual phenomena occurring on an average twice a month for over 4 years. (3) The memory of troops firing at him while he was surrounded by his friends.

It may be surmised that the association area in the brain from which the foreign body was extracted is one of the resting places of the intellect which brought to memory hearing and sight. It is the development of such a center (absent at birth and in the lower animals) which accounts for the fact that Beethoven was able to write and conduct his beautiful symphonies at a time when he was overwhelmed with deafness and deprived of the faculty of which he stood most in need.

AN EXPERIMENTAL AND CLINICAL STUDY OF THE USE OF RADIUM IN THE BRAIN¹

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THE many accomplishments of neurological surgery in the past thirty years have been made in the fields of surgical technique, diagnosis, and pathology. The perfection of the meticulous details of an osteoplastic craniotomy with complete hemostasis particularly during the removal of a tumor, replacement of the bone flap, and an accurate wound closure without drainage was the first important contribution. Attention was then turned to matters pertaining to diagnosis. Today the time has passed when headache, papilloedema, and vomiting must be present before the diagnosis of an intracranial tumor may be made.

Of equal if not of greater importance than these matters was the microscopical verification and classification of the tumors exposed and a correlation of the pathological picture with the clinical course of the patient before and after operation. Today the neurological surgeon must be able to foretell not only the precise situation of the lesion but its probable pathological character as well.

Though remarkable progress has been made, there are still many intracranial tumors which cannot be removed completely by surgical means. This is particularly true of the gliomata which constitute about 45 per cent of all intracranial tumors. The correlation of the pathological and clinical characteristics of this group of tumors has made their subdivision possible, so that we are now cognizant of the difference in malignancy between the astrocytomata on the one hand and the glioblastomata on the other. However the present surgical methods employed which consist of removal of the tumor by suction, by resection of large portions of the hemisphere, or by the electrosurgical scalpel are not completely satisfactory. All of these methods entail a large surgical risk, a gross destruction of brain tissue with the possibility of many neurological residual symptoms, and finally there is the possibility of leaving tumor tissue behind.

There should be no question that any suggestion for improvement in therapy must be based upon surgical exposure of the tumor and its microscopical verification. Any therapeutic agent which could be employed so that the tumor might be inactivated *in situ* without destruction to surrounding normal brain tissue, would be a progressive step in the surgical therapy of the gliomata. The use of radium implanted directly into the tumor suggests itself immediately.

Danyss (6) was probably the first to study the effects of radium upon the central nervous system. In 1903 this investigator placed a radium bearing tube 1 centimeter in length over the spine and part of the skull of a mouse 1 month old. Within 3 hours the animal developed paralysis and ataxia; after 7 hours, convulsions; and 18 hours later the animal died. Mice 1 year old exposed in a similar manner died 6 and 10 days later. Three guinea pigs 8 to 12 days old in which the same radium tube was placed beneath the skin over the lumbar cord for 24 to 48 hours developed complete paralysis of the posterior part of the body after 1 to 3 days. Adult guinea pigs and rabbits treated in a similar manner showed no lesion of the spinal cord but succumbed 3 weeks later to infection. An adult rabbit exposed to the radium tube for 8 hours was normal for 2 days and then developed hemiplegia on the third day.

Later the same author (7) exposed mice confined in wooden cages to 23 milligrams and 50 milligrams of radium bromide which was fastened in a hole in the lid of the cage. The time of exposure varied between 4 hours and 30 days. The animals developed alopecia, dermatitis, and paralysis and some died. Microscopically the tissue showed vascular changes consisting mainly of ruptured capillaries, but no changes could be demonstrated in the nerve cells.

In 1903 London (11) exposed young mice in a small glass cage to 30 milligrams of radium

bromide fastened on the cover. All the animals died after 4 or 5 days. The symptoms were insomnia, restlessness, and weakness which was followed by paralysis and coma. At postmortem examination hemorrhages were present in the subcutaneous tissues and in the dura over the cerebral cortex. In subsequent experiments (12) he found atrophic nerve cells in the spinal cords of 3 rabbits which had been exposed for long periods to 25 milligrams of radium.

Heineke (9) found deep hemorrhagic areas with softening of tissues at the site of application in a rabbit which had carried 20 milligrams of radium bromide on its head for 14 days. The rabbit was well for 3 weeks and died suddenly with spastic symptoms.

An intense reaction in the meninges was observed by Scholtz (20) in rabbits in which 25 milligrams of radium bromide were fastened to the head for 1 to 3 hours.

Obersteiner (13, 14) observed large and small hemorrhages in the cerebrum, cerebellum, and medulla with perivascular round cell infiltration. The nerve cells remained unaltered in mice whose heads were exposed to diffuse radiation. The severity of the symptoms depended upon the age of the animals, the duration of the exposure, and the amount of radium used. The symptoms were for the most part a direct or indirect expression of circulatory and metabolic changes produced by the radium. Similar effects—punctate hemorrhages without changes in the nerve cells—were noted by Alquier and Faure-Baulieu (1) in the brains and the cords of rabbits which were exposed to external radium applications.

In 1911 Horsley and Finzi (10) placed 55 milligrams of radium bromide on the pre- and postcentral gyri of monkeys for $2\frac{1}{2}$ to 4 hours. The rays were filtered through 0.5 millimeters of platinum and 1 millimeter of rubber. None of the animals showed symptoms after 26 to 45 days when they were sacrificed. Examination of the brains showed thickening of the dura with infiltration of the pia and arachnoid by erythrocytes and leucocytes. There was an endothelial hyperplasia of the blood vessel walls in some places so marked as to occlude the lumen. The first

two layers of the cortex were the seat of punctate hemorrhages. No changes in the nerve cells were discovered.

Williamson Brown and Butler (21) placed 50 milligrams of radium element filtered through 0.4 millimeters of platinum upon the motor area of the cerebral cortex for 4, 6, 12, and 18 hours. They found that within a radius of 4 millimeters from the tube a 12 hour exposure caused complete destruction of brain cells and interstitial tissues. The blood vessels showed marked thickening and hyalinization without rupture of the walls. In a second zone 1 millimeter in diameter outside the former area the cells were not destroyed completely but showed distinct signs of degeneration. The authors concluded that 50 milligrams of radium acting for 18 hours produce a destructive effect upon the tissues within a radius of 5 millimeters. The effect upon the blood vessels varied with the dose and the distance from the radium focus.

Bagg (2) studied the effects of glass capillary seeds containing radon upon the mammalian brain. He found that the tissue in the immediate vicinity of the tube became completely necrotic. Surrounding this area was a zone of polynuclear leucocytes beyond which there was a zone of hyperemia. At the end of 24 hours the zone of necrosis was 1 millimeter wide. The maximum effect was reached at the end of 2 weeks when the lesion was 1 centimeter in diameter. Each glass capillary seed was 3 millimeters long, 0.4 millimeters in diameter, and 0.1 millimeter thick.

In an effort to study the functional rôle of the group of nerve cells composing the corpus striatum Bagg and Edwards (3) implanted similar glass radon capillary seeds into the corpus striatum of dogs. One tube was implanted into each dog by means of a trocar introduced through a 2 millimeters trephine opening into the skull. Six weeks after insertion there was a localized destructive lesion consisting of an inner area of necrosis 4 millimeters in diameter surrounded by a ring of fibrin and then an outside zone 2 to 3 centimeters wide which showed edema, and a rich cellular exudate. Microscopical examination of the lesion showed a central partly cystic area of softening discolored by methemo-

globin. In this area there was a collection of large round cells distended by fat droplets and yellowish granular pigment. The lesions were sharply demarcated and the surrounding brain tissue showed no alteration in structure.

Pendergrass, Hyman, House and Rambo (16) have studied the effects of radium upon the normal tissues of the brain and spinal cord of dogs, both by surface applications and implantation. The surface applications were made over the parietal cortex the radium tube being placed on the dura. In the implantation experiments two needles were inserted in each dog through an opening over the parietal lobe. Surface application was made with platinum or silver tubes of 0.5 millimeter wall thickness, 2.8 centimeters long and 3 to 5 millimeters wide. Steel needles used for implantation measured 2.8 centimeters long, 1.5 millimeters wide and contained 10 to 12.5 milligrams of radium element. With external applications all of the dogs which received 1,150 milligram hours or less showed no symptoms. All of the animals which received 1,400 milligram hours or more died. Two of the dogs in which interstitial radiation was used developed general peritonitis and 1 developed meningitis from which they died. These same authors also found that an exposure to 600 milligram hours of radium over the spinal cord caused marked clinical symptoms. Areas of necrosis were found two segments above and below the lesion of direct contact. In addition to the local area of necrosis an increase in weight of the irradiated hemisphere indicated the presence of edema. The authors state that the cause of death in the dogs was not due to a local effect upon the brain but to toxemia. They noted that many changes were found following exposures which gave no clinical signs or symptoms, and they concluded that an exposure of normal brain tissue up to 1,150 milligram hours is compatible with life.

Carnes and Fulton (4) using cats and monkeys, implanted radon seeds 1.5 centimeters long with 0.3 millimeter platinum filtration alongside the spinal cord but extradural in the dorsal region. With large doses (31 millicuries) signs of weakness of the hind extremities appeared 30 hours after operation. The

paraplegia became complete 3 to 4 days after the onset. With smaller doses the time of onset of the first symptoms was later and the appearance of the complete paraplegia correspondingly delayed. In cats any dose greater than 9.5 millicuries produced complete paraplegia. Monkeys proved more resistant than cats because a dose of 12 millicuries produced only slight weakness. The first symptom exhibited was loss of the sense of position which was followed several hours later by motor weakness. The animals invariably passed through a stage of extension before developing a characteristic, complete flaccid paraplegia.

Carmichael and Ross (5) performed a series of experiments in which they placed radon seeds within and upon the dura mater and radium needles upon the dura mater. They used 5 millicuries of radon with 0.3 and 0.5 millimeters of platinum filters. The animals were sacrificed from 1 hour to 61 days, during all of which time the radon seeds or radium were in place. They concluded that following the use of radon seeds the endothelium of the blood vessels showed the first changes, then an emigration of leucocytes occurred, followed by local destruction of the cerebral cortex and finally hemorrhage. Fat was found in the blood vessels and after 94 hours thrombosis had occurred. Microglia cells loaded with fat were found in the subarachnoid space and in the perivascular spaces. The nerve cells stained poorly, neurofibrils were fragmented and the myelin sheaths were segmented and stained faintly. It was found that repair was evidenced after 212 hours of exposure by a proliferation of astrocytes. One half milligram needles of radium showed a very local effect. The authors reported that they had used radon seeds in 2 cases of pituitary tumor, 1 choroid plexus papilloma, 1 meningioma, 1 metastatic carcinoma and 3 gliomata.

Sargent and Cade (19) prefer the implantation of radium needles into tumor tissue but believe that interstitial radiation has a limited field because of the effect of radium upon blood vessels. These authors have used radium needles in several patients with intracranial gliomata and record dosages as large

as 3.721 and 5.184 milligram hours. They also used external, or surface irradiation with intermittent exposures of from 14 to 18 hours daily for 2 to 3 weeks or from 4 to 6 weeks if no interstitial radiation had been used. Three of the cases reported upon were oligodendrogliomata, a type of glioma which ordinarily has a good prognosis.

Ross (18) in a later paper has pointed out that radon seeds produce a local necrosis of cerebral tissue associated with hemorrhage and that radium element produces a more uniform radiation than radon. It would appear that Ross assumes that the changes produced immediately about the needle tract are due to the effect of radium.

The effects of implanting radium into brain tumors have been reported by various observers. In 1920 Frazier (8) reported 3 cases. The first patient was 13 years of age and had an inoperable tumor of the cerebellopontile angle. Eighty-five milligrams of radium were implanted in the tumor for 15 hours. Three years later there were signs of recurrence and a second radium implantation was performed. Six years after the first treatment the patient was still living and while symptoms of cerebellar disturbance were still present the condition was stationary. The second patient was a child with a serious disturbance of cerebellar function. A suboccipital decompression and radium implantation resulted in extraordinary improvement. Eight years after the treatment the child was reported to be in perfect health. There is no information upon the amount of radium or the technique employed in this case, and the nature of the tumor was not verified by microscopic examination. The third case was that of a patient 30 years of age who had been operated upon 19 months before admission because of disturbance in vision due to a pituitary lesion. Radium was applied to the pituitary body through the posterior nares. The treatment was followed by marked improvement and there was no evidence of recurrence 3 years later. The author mentions that in no instance had a glioma been benefited by radium treatment.

Pancoast (15) states that based upon the work of Pendergrass, the surface dose of radium to the brain over a limited surface area

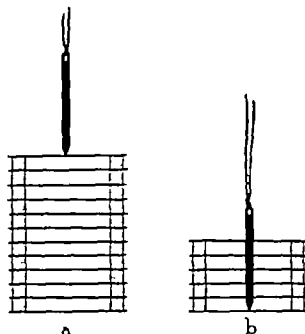


Fig. 1. Diagram to show methods of exposing photographic films to the radium needle.

should not exceed 1,400 milligram hours, though Frazier has given 1,445 milligram hours to a large cerebellar tumor without untoward results. He was of the opinion that radium implantation alone in safe doses is inadequate for the tumor and must be supplemented by external radiation.

Recent developments in our knowledge of radiation therapy have established certain fundamental principles that have an important bearing upon treatment. Thus it has become recognized that an optimum time interval exists during which a tumor reacts best to radiation. Exposure of the growth during a shorter period results in failure to gain a maximum lethal effect upon the tumor cells. Exposure over a longer period results in the establishment of a state of radio-immunity. The importance of utilizing the most penetrating rays of radium has led to the use of adequate filtration and a recognition of the significance of homogeneous distribution of radiation has resulted in the use of external radiation whenever possible and multiple implants when interstitial irradiation is indicated.

Since these principles have become recognized it is not difficult to explain many of the failures of radiation therapy under the older technique. The use of glass radon seeds, for

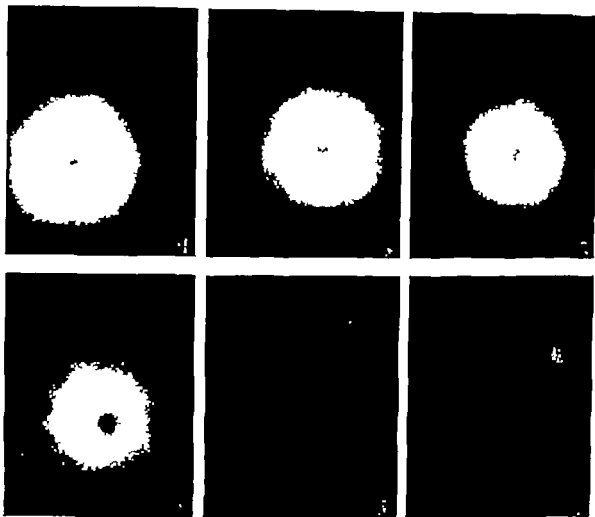


Plate V

Fig. 2. Exposures of photographic films to milligram radium needle. In Plate V the needle was suspended above films which were separated by a distance of 3 millimeters. The uppermost three photographs are the first three films, reading from left to right. The lowermost three films are the films which were the farthest away from the radium needle. The film in the lowermost right hand corner was 24 millimeters away from the tip of the needle. Note the varying size of

example invariably caused necrosis on account of the absence of filtration and the frequent failures of gold implants can be explained on the basis of inadequate filtration and the difficulty of effecting a uniform distribution of radiation except in lesions of limited size.

These considerations have resulted in important changes in technique in recent years. The ideal form of radiation therapy is that which permits the delivery of an adequate uniform dose of penetrating irradiation over a prolonged but limited interval for example by the use of a large quantity of radium at a

distance. In the treatment of the more radio-resistant tumors, however the amount of radiation that can be delivered to the lesion by external radiation may be inadequate and interstitial radiation becomes necessary in order to deliver an adequate dose to the tumor. Under these circumstances the use of multiple weak radium foci adequately filtered and uniformly distributed becomes the method of choice. With a few isolated exceptions removable platinum iridium needles of 0.5 millimeter wall thickness, containing radium element have proved to be superior to

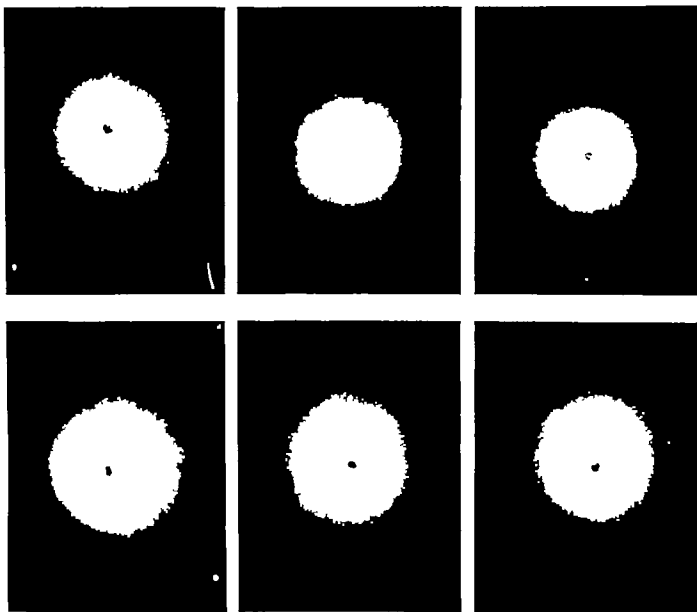


Plate B

the exposure effect upon the film. In Plate B the radium needle was placed through the films as illustrated in the diagram in Figure 1 b. Note that the exposure effect upon the films was equally as strong in the lowermost as in the uppermost film and that the extent of the radiation from the needle was uniform along its entire course.

any other method of interstitial radiation. The radium element is distributed throughout the platinum needles in such amounts that the total dose determined by clinical experience is delivered over a prolonged period of approximately 5 to 7 days. This distribution of radium permits the use of a small quantity of radium over a period of 120 to 168 hours rather than a larger quantity over a period of 10 or 12 hours. In the treatment of cancer of the tongue, for example, the use of this method has proved highly successful. Within the last few years the use of removable

platinum radium needles has been extended to the treatment of other neoplasms notably inoperable carcinoma of the breast.

Although radium implantation has been practiced in tumors of the brain and numerous studies have been made upon the effect of radium on normal brain tissue most of these observations were conducted before these basic principles were fully recognized and the radiation was not executed in accordance with the newer technique embodying these factors.

The prime purpose of these experiments was to study the effect of removable radium

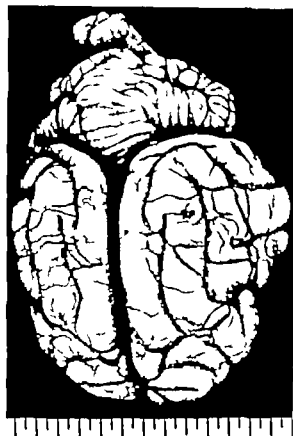


Fig. 5. Brain of Cat Ra No. 6. Note the discrete wound in the cortex made by the radium needle and the absence of reaction about it.

needles upon the normal brain tissue of animals and man under conditions in which the irradiation is delivered according to the modern concepts of adequate filtration, prolonged exposure and homogeneous distribution.

EXPERIMENTS

Ten cats, 9 dogs and 1 monkey were used as the experimental animals. Platinum iridium needles with walls 0.5 millimeter thick, 22 millimeters long, which contained 1 milligram of radium element were employed for implantation.

With two exceptions the radium needles were implanted in the parietal area of the cerebral hemisphere. In 2 cats, implantations were made into the cerebellar hemisphere. In one series, one needle containing 1 milligram of radium was implanted and left in place for 24, 48, 72, 96, 120 and 216 hours. The animals were sacrificed at the end of those pe-

riods. In another series, 4 milligrams of radium were implanted for periods of from 48 to 216 hours; the total number of milligram hours therefore were from 192 to 864. After the radium needles were removed the animals were allowed to live and were sacrificed at intervals of 20 to 168 days.

It became evident early in the course of the experiments that the animals would tolerate a larger number of radium needles provided a small amount of bone was removed and the dura mater was left open over the site of the implantations. The needles were introduced into the brain at intervals of about 1 centimeter about the circumference of a circle. The fine silk sutures attached to the eyes of the needles were placed beneath the temporal muscle. It was believed that each radium needle would exert its maximum effect at a distance of 1 centimeter and that in applying this method of therapy to intracranial tumors it would be necessary to place the needles within the tumor at 1 centimeter intervals.

In an attempt to demonstrate the limits of the area of radiation from a 1 milligram radium needle of the type used, we exposed a pack of 12 photographic films separated at intervals of 3 millimeters. The needle was suspended above the films in a darkened room for 24 hours (Fig. 1). It will be noted that the intensity of the shadow varies so that the bottom film showed no registration from the radium. Therefore the maximum radiation occurs within 1 centimeter from the tip of the needle. In another pack of 6 films, also separated by a 3 millimeter interval, the needle was inserted through the films (Fig. 2). It may be seen that along the entire length of the needle the area of radiation is of the same intensity and size.

None of the animals, regardless of the number of milligram hours of exposure and the time of sacrifice, showed any symptoms of damage to the central nervous system. It is true that the implantations were made in a relatively silent area of the cortex but it is clinical proof of the fact that the radium did not injure the brain at any great distance from the site of its implantation.

The brains were removed in every instance after formalin fixation *in situ* and there was



Fig. 4.

Fig. 5

Fig. 6

Fig. 4. Photomicrograph to show the thrombosis of a small vessel in the cortex about the region of the needle tract.

Fig. 5. Photomicrograph that shows a large number of

gitter cells loaded with fat about the tract of the needle wound. (Herxheimer fat stain.)

Fig. 6. Normal nerve cells in an area 6 millimeters away from the needle tract. (Cresyl violet stain.)

no operative or therapeutic mortality. Coronal sections of the brain were embedded in paraffin and in celloidin. Microscopic sections were cut at 10 millimeters to 30 millimeters in thickness and were stained by the hematoxylin-eosin Van Gieson, Cresyl violet and Weill methods. Frozen sections were made and stained by the Herxheimer, Cajal nerve fiber and gold sublimate methods, Kanzler's method for microglia, Ortega's IV, and Penfield's combined method for oligodendroglia and microglia.

The brains of two animals may be described as typical of the series in which the radium was inserted and the animals sacrificed at intervals of 24 to 216 hours. In Cat Ra No. 6 a 1 milligram needle was inserted in the left parietal cortex on December 22, 1931, and the animal was sacrificed December 28. During that interval the animal had been quite normal in every respect. The cortical vessels of the left hemisphere were a trifle more prominent than those on the right, but otherwise the appearance of the two halves of the brain was identical. The needle wound was discrete and there were no immediate gross meningeal changes about it (Fig. 3). This brain had therefore received 144 milligram hours of radiation.

Upon microscopic examination a collection of polymorphonuclear and round cells were

evident at the site of insertion of the needle and were localized to this area. The leptomeninges were slightly thickened immediately external to the needle tract but over a very limited area. The blood vessels of the left hemisphere were large and filled with blood cells. There was no apparent thickening of the endothelium of the vessels, but there was a thrombosis of many of the small vessels about the region of the needle tract. This thrombosis extended about 3 millimeters away from the border of the immediate lesion (Fig. 4). The tract of the needle was necrotic and hemorrhagic. There was no evidence of fibroblastic infiltration of the lesion but numerous gitter cells filled with fat were present (Fig. 5). The gitter cells showed evidences of migrating to the vessels in the vicinity of the needle tract though few were present in the perivascular spaces. Demyelination was distinctly limited to an area less than a millimeter distant from the needle tract. Within that zone many myelin sheaths still remained but were greatly swollen. The nerve cells in the immediate zone were slightly swollen and vacuolated. There was very little evidence of neuronophagia. At a distance of 2 millimeters from the needle tract all the architectonic structure of the cortex was normal, with the exception of thrombosed small blood vessels as has been mentioned.



Fig. Photograph of Dog Ra No. 4. Four milligrams of radium have been implanted in the cortex and allowed to remain for a total irradiation of 576 hours. They were then removed. This photograph was taken on the one hundred fiftieth day. A ray plate of skull of Dog Ra No. 4 shows the radium needles in place.

The brain of Cat Ra No. 8 showed the same type of changes after 216 milligram hours of exposure. The area of demyelination was well limited about the needle tract but not as closely as in those brains with smaller exposures. In the Cresyl violet stained sections there was a complete absence of nerve cells in the zone of destruction with only a few scattered greatly swollen cells remaining with barely discernible nuclei. The cytoplasm in those cells was vacuolated and the processes were absent. The Nissl granules were absent. In the area just external to the zone of destruction the cells showed a similar appearance. The inner zone measured about 4 millimeters in width and the outer 2. There was a moderate increase of glial elements. The transition to the normal cortex occurred within 6 to 8 millimeters from the needle tract (Fig. 6)

As has been stated in a second series of animals 4 milligrams of radium were implanted for as many as 216 hours, and after the needles were removed the animals were allowed to live from 2 to 168 days. In Dog Ra No. 4 for example, four 1 milligram needles of radium were implanted and allowed to remain for a total irradiation of 576 hours and then removed. The animal was allowed to live for 150 days and remained in excellent condition throughout (Fig. 7)

In the area of the needle tract in this animal's brain there was an increase in fibrous tissue which had grown in to fill the defect. Small collagen fibers passed directly from the leptomeninges into the brain (Fig. 8). In the Well stain the destruction and demyelination of the myelin sheaths was limited sharply to the edge of the needle tract and there was no residual swelling of the myelin sheaths at the edge of the lesion (Fig. 9). The nerve cells in the region of the tract were smaller than normal so that the nucleus appeared out of proportion to the cell body. The cytoplasm of some of these cells stained darkly while in others it barely stained at all. The Nissl granules were not well defined in either type of cell. In those nerve cells with lightly stained cytoplasm the processes had broken up and were retracted while in those with a heavily stained cytoplasm the processes could be seen clearly. Neuronophagia was noted with from 4 to 8 cells about each nerve cell (Fig. 10). Astrocytes and oligodendroglia both were present but the latter predominated (Fig. 11). The gutter cells which were so prominent in the brains of those animals which were sacrificed immediately upon removal of the radium, were absent except for an occasional one about a blood vessel. The microglia were not present in any greater number than is normal. These microscopic changes gradually faded away until at a distance of 1 centimeter from the needle tract the normal architectonic structure of the brain was present.

SUMMARY

In summary, then the pathological changes consisted of a central zone of destruction immediately in the tract of the needle wound.



Fig. 8.

Fig. 8. Photomicrograph which shows the presence of small collagen fibers which pass directly from the leptomeninges into the brain in Dog Ra No 4 (Van Gieson stain)

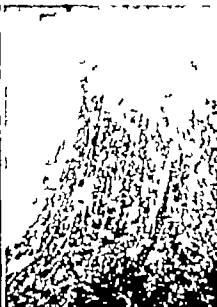


Fig. 9

Fig. 9. Photomicrograph showing destruction of myelin

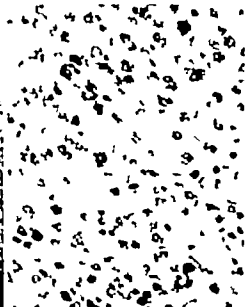


Fig. 10

sheaths which was limited sharply to the edge of the needle tract. (Weil stain)

Fig. 10. Photomicrograph showing neuronophagia with 4 to 8 cells in Dog Ra No 4. These changes occurred within 4 millimeters of the needle tract (Cresyl violet stain)

In the brains of those animals killed at the end of the period of exposure gutter cells loaded with fat thickening of the blood vessel endothelium with thrombosis of smaller vessels, amyelinization and slight chromatolytic changes in the nerve cells were the prominent features. In the brains of those animals in which some reparative processes had time to occur the gutter cells had disappeared, astrocytes and oligodendroglia cells were present in large numbers and neuronophagia was present. The important fact to be recognized is that all of these pathological changes gradually faded away to the normal within the radius of a centimeter from the central zone of destruction.

CLINICAL EXPERIENCES

Thus far our clinical experience in the use of radium needles implanted within the brain is limited to one case and therefore this portion of our work is in the nature of a preliminary report.

Our primary object was to determine first of all whether or not the use of radium element implanted in the brain according to the technique we have described would produce damage to the surrounding normal brain

structure. When it appeared that irreparable damage did not occur we felt justified in using it in an intracranial glioma. We believe that the case herewith reported was a severe test of the practicability of its use and that its future employment in these extensive gliomata should not be discouraged by the final result in this patient.

Headaches vomiting mental changes convulsive seizures of 8 weeks duration—terrible glioblastoma of left temporal lobe—osteoplastic craniotomy—implantation of eight 2 milligram radium needles—2,688 milligram hours exposure—death 2 months later

W. M. aged 14 years Michael Reese Hospital B48570

In February of 1932 the patient began to complain of severe headaches accompanied by vomiting. His memory was very poor and his mother stated that he acted queerly and became very difficult to manage. When he attempted to walk he became very unsteady and often fell to the floor unconscious. He would become rigid and then would have generalized clonic movements accompanied by incontinence.

Examination The skull was large but there was no tympanic note upon percussion. The left pupil was larger than the right and did not react to light. The right palpebral fissure was wider than the left. There was a high grade bilateral papilloedema with retinal hemorrhages. The right side of the face was weaker than the left and there was marked weakness in the right upper extremity. There was a pro-

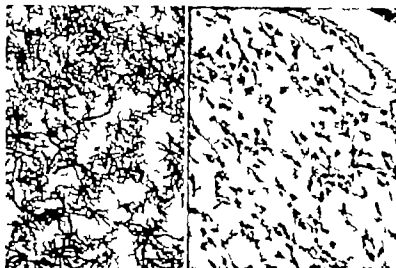


Fig. 1. left. Photomicrograph to show predominance of astrocytes immediately about the needle tract. (Cajal gold stain)

Fig. 12. Photomicrograph of tumor removed from patient. This is a glioblastoma.

nounced ptosis of the left upper eyelid with difficulty in moving the left eyeball to the midline. There were no sensory changes. The boy had no aphasia, apraxia, or astereognosis. His visual fields could not be determined accurately because of his mental instability. His attention could not be held and his emotional outbursts were frequent.

Operation. It was many weeks before an operative permit could be obtained from his parents. On April 8, 1932, a left osteoplastic craniotomy was performed. The child had become stuporous and had to be fed artificially.

One and one-half centimeters below the surface of the temporal lobe near its anterior pole, a large, soft, gelatinous reddish yellow tumor mass was found. In areas it was firm but for the most part the tumor was quite soft and jelly like. The cortical cap was removed with an electro-surgical unit and a portion of the tumor was removed by a curette and a sucker. Microscopically it was a glioblastoma (Fig. 12).

Eight 2 milligram radium needles were implanted into the tumor mass at intervals of about 1 centimeter. The dura mater was left open over the temporal lobe and the bone flap was removed (Fig. 13).

Course. The immediate postoperative condition was precarious but after 12 hours his blood pressure rose to 90/50 and he was taking fluids by mouth. His temperature was 103.6 rectally and his pulse 150. Edema of the left eye and face began. He talked and moved his right arm and leg as well as he had previously. Within 24 hours the edema of his face had increased but he was more alert and his blood pressure was 128/78, pulse, 120 and temperature 98.4. His recovery then progressed rapidly so that within 48 hours after operation the edema had disappeared entirely.

Operation. On April 15, 1932, after he had received 2,683 milligram hours of radium exposure the flap was elevated and the radium removed.

Course. The patient's recovery was excellent. The wound healed well, except for a slight necrosis of its anterior limb, which eventually disappeared (Fig. 14). His mentality became greatly improved and he was allowed to be about his ward untroubled.

Six weeks after the removal of the radium his hair began to disappear and he became bald over the left side of his scalp.

On June 2 the patient became drowsy and hypertonic intravenous solutions did not produce any change in his condition. He gradually failed and died on June 11, 1932.

At the outset it was quite apparent that we were dealing with an extensive lesion which had grown rapidly toward the midline, as well as into the frontal lobe. He became somnolent and unresponsive, a state from which he could not be aroused by hypertonic solutions. Although the final result may have been so different, it was not until his parents saw him in this moribund state that they consented to operation.

The postoperative edema about this boy's face and left eye was more marked than we have ever seen following a craniotomy. It did not include the scalp over the bone flap and we are inclined to believe that it was due to an unusual circulatory stasis rather than to



Fig. 13. X ray plates of skull to show position of eight 2 milligram radium needles implanted into the tumor of the patient. Small silver clips are to be seen on the blood vessels of the cortex

any direct effect from the radium. He did not have an unusual postoperative rise in intracranial tension which might have been due to oedema produced by the radium. Disappearance of the hair over the left side of the scalp was a late effect which was expected. The area of depilated scalp was considerably larger than the circumference of the area in which the needles were implanted.

We have no way of knowing accurately the duration and exact time of onset of the symptoms in this patient because of the inaccuracy of the history. The microscopic picture of the tumor which was classified as a glioblastoma led us to believe that the prognosis following operation would be unfavorable since it is known that the clinical course of the glioblastomata is shorter than other tumors of the glioma group. These large succulent tumors produce tremendous oedema and intracranial tension. They grow rapidly often extending throughout both cerebral hemispheres. They have been proved to be little influenced by X ray therapy or by radical surgical operative procedures.

It is more than unfortunate that an autopsy permit was not granted because it leaves unanswered the important questions of the exact extent of the tumor and the effect of the radium upon the remaining tumor tissue and the

surrounding normal brain. These are matters for future study.

We may be certain however that the implantation of radium needles and their subsequent removal is a practical procedure the success of which may be influenced by the care which is taken in the closure of the craniotomy wound.

DISCUSSION

The direct effect of radium upon tumor tissue has been investigated many times and though we wish to record our observations



Fig. 14. Photograph of patient 14 days after removal of radium needles.

upon this point as our experience increases it is not the primary point with which we are now concerned. Our aims were to establish whether or not radium could be placed within the brain for long periods without a fatality to the patient and without serious damage to the surrounding brain structure. Our experimental evidence and meager clinical experience would lead us to believe that radium implantation into the brain in small doses, properly filtered and left for many hours is tolerated extremely well by animals and by man. This is particularly true if an adequate decompression is made to provide for any possible rise in intracranial tension.

Though a destruction of brain tissue occurred about the margins of an intracranial tumor we would sacrifice it gladly for the advantages of treating such a tumor more adequately than we are able to do at present. However we believe that such a destruction of cerebral tissue does not occur certainly not beyond a radius of 1 centimeter. This means, therefore, that we believe that many of the pathological findings we have described may have been due alone to the introduction of a blunt needle into the brain. It has been shown by Penfield (17) that about the track of a blunt needle, compound granular corpuscles occur in larger numbers, that the astrocytes send in large expansions concentrically and in general a cicatrix results which contains connective tissue and causes gliosis and a distortion of the brain. Our results, therefore, are in accord with those of earlier investigators in that they show that radium in the doses which have been used does not materially injure normal brain tissue.

The tendency for radium and X-ray therapy to increase the capillary supply of the area treated was a question which arose during the investigation. We concluded that the pial vessels of the cortex were not increased in size or number and that we could discount the possibility of the development of a telangiectasia. Finally there was no microscopic evidence of an increased vascularity nor was there in any instance a tendency for secondary hemorrhage to occur.

In none of the animals and in the single clinical experience there was no disturbance

of the heat regulation mechanism. Though the needles were in many instances close to the ventricular walls, there was no destruction of the wall and no ventricular hemorrhages occurred.

It must be remembered that some of the gliomata have a more embryonic structure than others further that the clinical course of some of them is longer before and after operation than others. The general experience of neurological surgeons with deep roentgen-ray therapy is in accordance with these two facts, though an exact law of behavior of the tumors to radiation is not possible. We have no doubt that such may prove to be the case with the use of radium. It is unlikely that the astrocytomata or oligodendrogliomata which have a relatively slow clinical course will be affected greatly. However it is the outlying and peripheral extensions of these tumors which are in more active cellular division which we wish to inactivate by the implantation of radium needles. It is probable that a much larger initial dosage will be required for the glioblastoma group, an example of which we have reported upon.

CONCLUSIONS

1. The ideal form of radium therapy by implantation of needles is that which makes use of multiple weak radium foci adequately filtered and uniformly distributed over a period of 120 to 168 hours.
2. Radium element implanted into the brains of animals under such conditions produces no destruction of normal brain tissue.
3. It is surgically practicable to implant radium needles in a brain tumor and remove them after the period of radiation.

We wish to express our thanks to Mr. L. H. Terrell for his help in preparing the microscopic sections.

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SOME PRINCIPLES INVOLVED IN THE PATHOLOGY AND TREATMENT OF EMPYEMA THORACIS

WITH PARTICULAR REFERENCE TO TREATMENT BY PERIODIC ASPIRATION OR EVACUATION WITH AIR REPLACEMENT WITHOUT DRAINAGE¹

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THE pathology of empyema differs in only one respect from the pathology of infection of the peritoneum or any other endothelial cavity namely in that pus forms in an area in which negative pressure exists. Whereas, in the abdomen a simple incision into the cavity and sufficient drainage to permit all the products of the suppurative process to escape are usually sufficient for the establishment of a cure in empyema the presence of negative pressure complicates the mechanism of healing the cavity having a tendency to pull apart and stay open rather than to collapse.

The pleural cavity may be infected in one of three ways

1 By the direct introduction of contaminated material through a wound including an operative wound

2 Through the blood stream This is very rare for even when blood stream infection does occur it usually involves infection of the subjacent tissues before the endothelial lining itself is infected so it is not a direct blood stream infection of the pleural cavity

3 By the spread of infection from an adjacent organ or tissue This is the usual mode of infection and may occur first by the spread as in pneumonia or influenza of an inflammatory process from the lung substance onto the endothelial surface second by the rupture of a cortical abscess of the lung which may either be so minute as hardly to leave any signs detectable at autopsy or it may be so large that the sudden pouring of its toxic contents into the pleura, especially if no adhesions exist may cause profound shock and even perhaps death before any surgical procedure can be instituted. There may be any grade of severity between these two extremes. Again, the pleura may be infected by the rupture of a subphrenic or liver abscess through the

diaphragm of a chest wall abscess through the parietal pleura, an oesophageal lesion through the mediastinal pleura by the rupture or spread of a suppurative process in osteomyelitis of the ribs, of a similar lesion of a vertebra or by the spread of infection from a purulent pericarditis

A single pocket of pus will form if the focus of infection is a single one the inflammatory process a slow one the bacterial infection not highly virulent and if it is situated in an area where there is little motion as in the upper portion of the chest, in an interlobar space or in the immediate neighborhood of an adherent area These conditions permit sufficient time to elapse for the formation of adhesions This pocket will be small at first, containing little fibrin. It will grow gradually in size and if not incised or drained or otherwise emptied will finally overcome the cohesive force of fresh adhesions and rupture into and involve the entire pleural cavity giving rise to symptoms of shock and toxemia as in the rupture of a lung abscess. Where, however the surrounding adhesions are very firm, a rupture may take place through the lung parenchyma into a bronchus and be drained partially in this way More rarely it may break through the parietal pleura into the tissues of the chest wall and finally point on the surface or similarly invade the pericardium or subphrenic area

If the focus is situated in an area where the lung moves widely and freely or if there are a number of scattered small foci, or infected material is poured rapidly or in any great quantity into the pleural cavity and if the infecting organism be of a highly virulent type giving no time for the formation of protective adhesions then the entire pleural cavity on that side will become involved as one large abscess cavity This is the type usually

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Figs. 1 and 2 Drainage tubes of different variety in place and cavity in each case entirely empty of pus and filled with air

seen as a complication of influenzal pneumonia. As the purulent fluid increases in quantity the lung gradually collapses and finally the heart and mediastinum may be pushed over toward the unaffected side. These large cavities may contain large masses of fibrin both adherent to the walls and floating in the fluid.

If a cortical abscess no matter how small communicating with a bronchus should rupture into the free pleural cavity a bronchial fistula will result. Reinfection of the cavity will continue till the fistula closes and air may be forced into the cavity at each effort at coughing or straining adding a spontaneous pneumothorax to the empyema the combination being known as pyopneumothorax. This latter condition occurs more frequently in children and following gunshot or stab wounds of the lung in adults. It presents the added danger of a possible tension pneumothorax which, especially in children may increase to the point of pushing the heart and mediastinum over so far as not only to diminish the actual breathing capacity to a point dangerous to life, but also to interfere with the circulation by pressure on the venæ

cavæ and innominate veins, thereby preventing the ready filling of the right heart. This danger is to be constantly remembered in treating empyema by any truly closed method.

No matter what treatment is instituted the empyema will persist and pus continue to re-



Fig. 3. Similar pyopneumothorax cavity in a third patient, immediately after drainage tube was removed and patient considered clinically cured.



Fig. 4



Fig. 5



Fig. 6

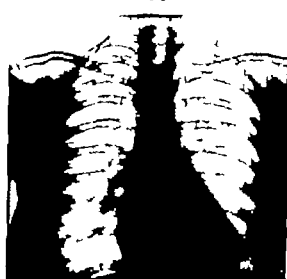


Fig. 7

Figs. 4, 5, 6, and 7. Various steps in air absorption and lung expansion in a patient treated by aspiration and air replacement. Figure 4 shows practically the same con-

dition as Figure 3. Note the diminution of density of the lung in Figures 5 and 6 as air is absorbed and the lung expands.

form until the source or focus of infection has ceased to pour infected material as it were into the pleural cavity. Thus bronchial fistulae and communications with a lung cavity or with any other infected area must close before the suppurative process can stop. Long continued bronchial fistula, or other persistent sinus opening into the empyema cavity is the most frequent cause of chronic empyema.

As brought out by Graham (9) a large empyemic accumulation involving more or less of the entire hemithorax even with virulent organisms may not very materially immediately endanger the patient's life if both lungs are otherwise comparatively normal.

But in the presence of any pathology which curtails the function of either lung and especially of the lung on the opposite side par-

ticularly if associated with the usual additional toxemia and exhaustion of a patient who is very sick from an acute pneumonic condition then even a very small empyemic accumulation may prove to be a very serious complication. Thus in pneumococcal empyema which develops after the subsidence of the acute pneumonic process, the condition is not nearly so serious as in influenzal empyema which usually develops during the progress of the acute influenzal process in the lung. The virulence of the bacteria present also influences the severity of the case.

HEALING OF THE EMPYEMA CAVITY

How does an empyema cavity heal? A *small* cavity may perhaps heal by granulation and cicatricial approximation of the separated pleural surfaces. It is difficult to conceive, however, that a cavity as large as half the chest cavity could possibly heal in this way. *Large* cavities diminish in size only to a very limited extent as a result of granulation and cicatrization. The main mechanism of healing after reinfection has ceased is by

1. Sealing of the cavity from the outside, resulting in a closed pneumothorax,

2. Gradual absorption of the remaining air, the lung being drawn out by the resulting increase in negative pressure until all air has finally been absorbed, when the cavity is obliterated.

In these larger sized cavities when all pus and all dead material including fibrin clots, necrotic tissue etc. have been removed or drained out, and the cavity ceases to be reinfected from within or without, pus practically ceases to re-form. So far as the walls of the cavity are concerned the condition is now analogous to the clean granulating surface of an abscess after all necrotic material has been cleared out. This is equally true whether drainage has been used or the contents have been removed by needle or otherwise. At this stage the infecting bacteria no longer float in a lake of pus which is a most favorable culture medium but lie in contact with and hence at the mercy of the activated fixed tissue cells which now amply care for what contact bacterial infection is left on its surface. Thus the cavity becomes practically

sterile soon after it is freed of all fluid and dead and extraneous material. The ability of an endothelial surface to care for a certain amount of bacterial contact infection is familiar to laboratory workers, who find it difficult to infect an endothelial cavity. Graham (8) found it very difficult to produce empyema in experimental animals by introducing even large quantities of bacterial laboratory cultures. The abdominal surgeon does not fear peritoneal contact with infected material if no gross fluid or solid matter remains and usually feels safe if he can wipe the contaminated surface clean.

To get back to our subject, we now have a clean cavity filled with air. The drainage tube, if any, may at this stage be surrounded by granulations and adhesions which shut it off from the cavity. In any event it traverses an area of greater or lesser depth of clean healthy granulations which will readily come together with rapid closure of the drainage sinus if the tube is now removed. Bacterial counts in smears taken from the wound are a valuable aid in determining the optimum moment for removal of the tube, though one can usually judge by the quantity and quality of drainage. A roentgenogram taken at this time will show a pneumothorax cavity of approximately the size of the original empyema cavity (Figs. 1, 2, 3). Identically the same picture is shown when aspiration and air replacement has been used (Fig. 4). The cavity now, sealed from the outside, gradually diminishes in size as the contained air is gradually absorbed, and is finally completely obliterated, as can be shown by repeated roentgenograms (Figs. 4, 5, 6, 7).

The impression seems to be general that these cavities fill from the bottom, as evidenced by the fact that the cavity will hold less and less irrigating fluid. Whatever may be the explanation of this phenomenon, the fact remains that it cannot be generally so, for if frequent roentgenograms are taken, no filling in of the cavity by granulations is evident and comparatively little diminution in the size of the cavity in the drainage cases takes place until the drainage sinus closes. After this the lung can be seen gradually expanding and approaching the chest wall.

During this process its shadow becomes not denser as it would if to the lung shadow were added the shadow of superimposed new granulations, but less dense owing to thinning of the lung substance as a result of its expansion and filling with air from within.

Some granulation and cicatrization does occur however not only around the tube but also in the angles of the cavity so that the cavity in this way grows somewhat smaller. If the process is of long standing continued inflammatory infiltration renders the lung surface more and more hard and unyielding its edges become firmly bound to the chest wall diaphragm or mediastinum, and there results the type of chronic empyema which is due to inability of the lung to expand as the air is absorbed.

In every case when healing has taken place and all air has been absorbed, the pleural surfaces are finally glued together over a greater or less area by firm organized adhesions. Where tube drainage has been used the adhesions are more pronounced and cover a larger area. In fact the opinion prevails that in all cases the entire surface involved becomes permanently adherent. An experience with two patients with pyarthrosis of the knee who were treated by aspiration and air replacement and who are well with practically no impairment of movement, makes me lean very strongly to the opinion of Forlanini that it may be possible. If little trauma is inflicted on the pleura by treatment to have the endothelial surfaces at least over a greater or less area finally free of adhesions. We know that this is so in the peritoneal cavity. True the frequency with which pleural adhesions are encountered at autopsy in patients never known to have had any such serious pathology as empyema may be cited as evidence that things are different in the pleura. But the question will bear consideration and investigation. I believe it not only possible but probable that in many cases treated by aspiration and air replacement, during the period of 2 or 3 weeks or more required for complete air absorption that follows clinical cure, the endothelial surfaces may revert to normal and glide freely over each other when they do come in contact.

I may say a word at this point as to the use of antiseptic washings. There should be no more need or indication for them here than in the peritoneal cavity or elsewhere. Most other abscesses do better without antiseptic washes or interference of any kind. Against this, however stands out the remarkable improvement and shortening of convalescence which followed the introduction of irrigation with Dakin's solution during the World War. This irrigation is still very popular and quite generally used. The solution it is said will cause the fibrinous masses to dissolve and drain out. If this is desired I wonder if papain (1:10) or some other digestant would not be more effective.

That the fibrin will liquefy is attested by the many cases of empyema that have during these recent years gotten well by the use of small catheter drainage and by some form of aspiration, in the greater number of which no irrigation has been used. For as experience with rib resection and open tube drainage has taught most patients have fibrinous masses that could not pass through a needle or small catheter. These masses, therefore must have been reduced to a state in which they would pass through a small catheter or aspirating needle.

DIAGNOSIS

The early diagnosis of empyema is not always easy. In cases in which a known hemothorax or marked serous effusion is infected and becomes purulent this may be readily determined by exploratory puncture. This is not however the usual way in which the largest number of empyema cases in civil practice begin. They usually start as a small intrapleural accumulation temporarily walled off by adhesions. This may be situated in any region of the chest cavity. If treatment is instituted in this early stage one has to deal with only a small accumulation. If the case however is not recognized early and no active treatment has been instituted the adhesions are finally overcome and more or less of the entire pleural cavity will be involved. The localization of a small accumulation is often very difficult. If deeply situated physical examination may reveal nothing abnormal. If near the surface there will be dullness and

diminished or even absent breath and voice sounds. Next to the finding of pus by needle puncture, roentgenography is the most valuable single means of diagnosis. It has however all the possibilities of error inherent in the interpretation of shadows. When pus is found, the localization and outline of the cavity may be very much facilitated by removing as much pus as possible even though a small quantity and replacing this pus with air. Roentgenograms now taken with the patient in a number of different positions and with the rays directed *horizontally* will show a fluid line with air above so that it is possible by a study of a series of views to outline definitely the entire cavity. If the cavity has been completely emptied of fluid with air replacement, it will stand out clearly in the roentgenogram in any one position.

One should never be satisfied that pus is not present because of a single negative exploratory puncture and the largest possible needle should be used for very thick pus will not flow through the usual aspirating needle. There may be two or more separate noncommunicating cavities each of which will require separate treatment. A small empyema pocket may be situated deeply in an interlobar area, or over the dome of the diaphragm or between the lung and pericardium or mediastinum so that healthy pleura or lung must be traversed in order to reach it. In such cases the course is to all intents and purposes like that in a lung abscess. In their drainage, open or closed one may cause infection of the general pleura or injury to the lung substance. It is sometimes very difficult to distinguish between an abscess and an empyema cavity. Here one's clinical sense must come to his aid. A patient with a lung abscess is usually much more seriously ill than one with an empyema cavity of equal size. If the abscess is cortical and adhesions exist, there is usually no serious danger in inserting a needle into it. One will meet, however, the occasional foul smelling anaerobic lung abscess, the puncture of which may result in an acute phlegmonous infection of the chest wall with the most serious consequences.

I have said nothing about pathognomonic physical signs of fluid in the chest. Areas of

dullness in empyema do not change with position as has been taught, even in large effusions, unless a considerable quantity of air is present, for the structures which surround an empyema cavity very early become fixed so that the lung cannot shift position in different postures.

PROPHYLAXIS

Can we do anything to prevent empyema? Children with whooping cough or other pulmonary conditions who have violent repeated spells of coughing should be given such remedies as will minimize the violence of the efforts at coughing and thus avoid, if possible the rupture of a cortical lesion and the production of spontaneous pneumothorax which may occur even without any lung pathology. Chest wall infections should be incised early. The same is true of liver and subphrenic infections. In making an exploratory puncture or in aspirating a serous effusion one should observe every aseptic precaution so as not to convert a serous into a purulent effusion. All effusions should be evacuated. Especially is this true of hemothorax. The chest should be emptied of blood just as soon as sufficient time has elapsed to make one reasonably sure that the hemorrhage will not recur. If the blood or serum is replaced with air, every drop of fluid can be withdrawn without altering the intrapleural tension. In fact, as brought out by Morelli, to prevent recurrence of hemorrhage or even to arrest it if persistent, a larger amount of air may be injected than the fluid removed, to the point of producing positive pressure if necessary. As the air during the ensuing 2 or 3 weeks is gradually absorbed the lung will gradually expand. Patients with chest lesions, whether inflammatory or traumatic, should be the object of solicitous care and should be frequently visited and examined by the physician or surgeon and frequent roentgenograms should be taken.

TREATMENT

Three methods of treatment of empyema are now in vogue. First, incision and open drainage with or without rib resection and with or without irrigation of the cavity. A

large rubber tube is the most generally used means of drainage. Some go so far as to advocate gauze packing of the entire cavity (2). Second closed tube drainage, a large catheter or similar tube being inserted through a small stab wound or by means of a trocar the tube being intended to fit so tightly that there is no leakage between it and the surrounding chest wall. Some form of suction more or less continuous, and some form of irrigation is the rule. Third aspiration.

I shall also discuss a fourth—periodic aspiration or evacuation of the pus with air replacement and without drainage.

Incision with or without rib resection and open drainage. This was the method generally in use until the outbreak of the World War. During the measles and influenza epidemics, the reports from the various Army hospitals in the United States to the Surgeon General's office showed the death rate from empyema after open operation to average 30 per cent in some hospitals and in others to run as high as 70 per cent. The Empyema Commission (20) found the highest mortality in the hospitals in which open drainage was instituted as soon as an effusion became purulent or pus was located. Everts A. Graham (9) a member of the Commission carried out experiments showing the manner in which a large opening in the chest wall endangered life the danger being proportionate to the size of the opening. He showed that in the prevalent type of streptococcal infection, the empyema developed while the lung condition was at its height, and not after its subsidence as in the pneumococcal type. He also showed that open thoracotomy could be done with a greater margin of safety later when the mediastinum became rigid as a result of inflammatory infiltration so that the disturbance of equilibrium incident to operation could not be transmitted to the lung and pleura of the other side.

The result was deferred operation. Temporary aspiration was done as indicated and some patients were cured by this aspiration alone. When operation was done later, openings only large enough to insert a tube were made and even the tube was protected by dressings or some special valve-effect appliance and its caliber diminished by smaller

tubes inserted for irrigation with Dakin's solution. This solution seemed to sterilize the cavity dissolve the fibrinous masses, and shorten the period of convalescence. Repeated wound cultures were taken and when the secretions were sterile or the bacterial count in smears from the wound reached a very low figure, the tube was removed. Treatment was more or less standardized along these lines, and a marked reduction in the mortality rate resulted.

As compared with other methods, open drainage has the following advantages (1) The surgeon has the satisfaction of looking into the cavity or removing a few large fibrinous flakes and even of putting his finger into the recesses of the cavity. (2) In most instances, unless there is later delay in healing, the surgeon is through with his work when the operation is finished and the patient has rallied from any resulting shock. No close, repeated personal observation is required on his part if convalescence is normal. In a large number of cases the patient may get well without his having seen him again, ample care being given him by the nurse. (3) Irrigation can be done if desired. (4) Tension pneumothorax is impossible. (5) Foreign bodies can be removed.

On the other hand (1) there is always shock of varying degree, depending upon the degree of rigidity of the mediastinum, the amount of lung disease present, and the care used in minimizing the effects of open pneumothorax by hand or gauze closure of the wound during the operative procedure, valvular closure of drainage tube, etc. (2) There is much secretion and drainage, requiring frequent abundant dressings, the patient being more or less constantly soaked in fetid pus and therefore a nuisance to those about him. (3) The tube may not be placed so as readily to drain the cavity and a second thoracotomy may be required. In this connection, many surgical textbooks describe the exact spot on the chest wall at which a thoracotomy should be done. I heard a very able surgeon who holds a high hospital and teaching position recently say he always resects the sixth rib in the posterior axillary line. Those who practice such a set rule will strike an empyema

cavity in most instances, if the entire pleura is involved I should have missed it in nearly half of my own series of cases. Evidently, these men very seldom see empyema in the early stages. Or do they drain at one spot and then find their way to the cavity by dissection, or separation of adhesions? (4) Occasionally a tube gets lost in the cavity with resultant embarrassment for the surgeon and trouble for the patient (5) As a result of the presence of the tube (a) some secondary infection is inevitable (b) pressure contact may result in intercostal hemorrhage ulceration into a bronchus, much granulation about the tube, and if long continued the formation of a thick walled sinus with greater tendency to chronic empyema than by any other method (6) There is always a deforming scar

Closed drainage As early as 1890 Forlanini reported 6 cases of empyema treated in the previous 2 years by this method. He recites a controversy at the Medical Congress in Vienna in 1889 between the advocates of wide open incision and drainage and the partisans of what he called the Bulau method which is exactly the closed tube method as practiced today. He favored the latter but said that complete emptying of the cavity was essential to a cure and the Bulau method did not remove all fluid at once. The fluid could only be removed by replacing it with air. He, therefore, by needle puncture or after introducing a Nélaton catheter through a trocar removed all fluid by repeated alternate suction of fluid and injection of air. He produced a negative pressure in the cavity by replacing the fluid with approximately one half its volume of air. This negative pressure he maintained by a sealed two-bottle gravity method. He aimed at keeping the cavity free of pus and favoring closure of the cavity by constant suction. He also used repeated washings of the cavity mostly with boric acid solution. This, except for the complete emptying by air replacement describes the present day method. In fact there is much talk to the contrary of keeping air from entering so as to prevent pneumothorax. This is a misconception of the principle of avoiding a marked open pneumothorax which means a free opening which allows air easily alternately to

enter and escape with each respiratory cycle. Forlanini's article would well repay reading by any one interested in this subject, for there is hardly any aspect of the pathology and treatment of empyema that he does not discuss, many of his terms being in the language of what is considered most up-to-date on the subject today. Morelli, Forlanini's pupil and successor, does a rib resection, inserts into the pleural cavity a large tube which traverses an hourglass inflatable balloon intended to give an air tight fit, irrigates with chloroform, and maintains negative pressure (Fig 12). This technique gave him excellent results in the treatment of fresh thoracic wounds.

Closed small tube drainage can be instituted without the shock incident to open drainage and without the dangers incident to an open pneumothorax. Irrigation of the cavity can be done if desired. Negative pressure can be maintained by some form of suction, this being by many considered desirable, as favoring earlier collapse of the cavity. Others encourage collapse by forceful blowing exercises against resistance. Forlanini used inhalation of air under pressure. I believe little is to be accomplished by any of these measures except in so far as they help to empty the cavity of pus. To the contrary, they may all have a tendency to favor the passage of fluid exudates from the lung into the cavity and to maintain or re-establish the patency of a bronchial fistula or infecting sinus.

As disadvantages of the method may be mentioned (1) The small tube may be blocked by plugs of fibrin, (2) it may not completely drain the cavity, (3) the tube may not remain air tight, air finally finding its way between it and the surrounding soft parts, favoring secondary infection, (4) to a lesser extent than in open tube drainage, granulations form about the tube and chronic empyema may ensue if drainage is of long duration (5) possibility of tension pneumothorax.

Aspiration As Forlanini well brought out, it is impossible to empty most empyema cavities completely of all fluid by aspiration alone. In fact, he divides them into three classes according to the degree to which the walls yield to suction (1) in which the walls yield

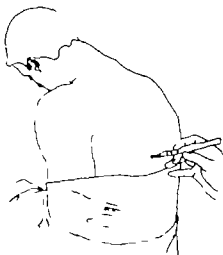


Fig. 8. Making small stab wound to facilitate introduction of large needle.

readily to aspiration (2) in which the walls yield later to continued suction (3) in which they never yield and thoracoplasty has to be done to collapse the cavity.

The accidental or incidental cure of empyema by aspiration is as old as aspiration itself. During the World War experience more than 10 per cent of the cases were cured by the aspiration which was done as preliminary to later thoracotomy. But no one has ever definitely shown that any great number of consecutive cases can be cured by aspiration alone. Nor have I ever made such a claim. It may occasionally be possible to remove most of the pus in an empyema cavity by simple aspiration. I think however that this rarely takes place. What often happens is that during the course of the aspiration air is permitted in some way to enter the cavity and that these cases are really being treated not by aspiration alone but by aspiration and air replacement.

Air may find its way into the cavity (1) by suction through the needle while disconnected from the syringe (2) by needle puncture of the lung, (3) by tearing of the lung by the force of aspiration. I recently discussed a paper (13) by an eminent pediatrician on aspiration in the treatment of empyema who stated that he had had no experience with aspiration and air replacement. I was able to show by one of his own lantern slides that

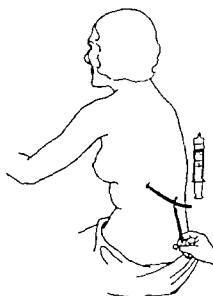


Fig. 9. Large needle attached to clamped rubber tubing and ready for connection to syringe. (First method of aspiration and air replacement.)

he had if accidentally and unknown to him practiced air replacement for he showed a cavity completely filled with air and completely empty of pus after one of his aspirations. Instances are on record (17-19) where the pull of forceful aspiration tore the lung substance producing a bronchial fistula and spontaneous pneumothorax and permitting free emptying of a cavity after previous repeated negative attempts. McEnery and Brennemann describe the incidence of pyopneumothorax after one or more aspirations and frankly attribute it to pulmonary trauma by the aspirating needle. They also cite an instance where a hypodermic needle used to give a cardiac injection of epinephrine perforated the thin leaf of left lung overlapping the heart, producing marked pneumothorax and when at autopsy the lung was inflated through the trachea, air bubbled out through the opening made by the small needle.

Periodic aspiration or evacuation with air replacement without drainage. Forlanini's article, already cited describes a method of emptying completely the chest of fluid by aspiration and air replacement. He gives Parker credit for first suggesting it. This same method was described and credit given to

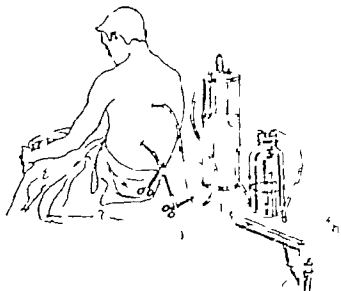


Fig. 10. Large needle connected to suction apparatus and smaller needle inserted higher up connected to pneumothorax apparatus, both controlled by forceps clamping. Glass tubing connection in lower tube near the needle end of the tube through which air bubbles can be watched for to determine when the cavity is empty of fluid. (Second method.)

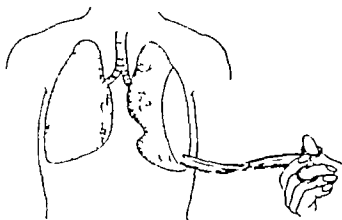


Fig. 11. Graphic demonstration of third method showing long forceps introduced through small stab wound permitting free flow of fluid outward and air inward and ready to grasp fibrinous masses that may present in wound

Forlanini by Morelli, his pupil and successor in a monograph on wounds of the chest in 1918. While serving with U S Army base Hospital No. 102 on the Italian front a short distance from Morelli's Special Hospital for thoracic wounds I became acquainted with this method through the same monograph and for a number of years after had occasion to use it in the removal of non purulent effusions.

If one tries to empty the chest of a fluid accumulation by simple aspiration with no air replacement one eventually has to stop without removing all the fluid for one of two reasons either the negative pressure becomes so great as to cause pain and respiratory or cardiac embarrassment or the needle will come in contact with the visceral pleura and cause pain, coughing dyspnoea and shock. If, instead, the fluid is gradually replaced with air as it is removed, the cavity maintains its original size and shape, and every drop of the fluid can be removed with practically no discomfort.

It did not occur to me to use this method in the treatment of empyema until 1923, when I had occasion to perform a temporary aspiration on a young woman with an empyema complicating an influenzal pneumonia. Hav-

ing found pus by exploratory puncture, I decided while the needle was still in place to remove as much pus as I could previous experience with aspiration with air replacement of non purulent effusions encouraging me in the belief that I should be able to do this without harm or discomfort to her. This I proceeded to do, easily removing 300 cubic centimeters of frank pus and replacing it with an equal volume of air. The patient improved remarkably immediately after this, and when a few days later I spoke of thoracotomy she suggested another aspiration which I did again replacing the fluid with air, and finally did the same thing a third time. Following this the patient was clinically well and has been well since. Thus my initial case was accidental and unexpected.

Two years ago I reviewed (3) 35 consecutive cases treated by this method. I have had a few more since, and know of some 75 more treated by others in New Orleans and elsewhere. The patients have been of all ages, varying from a few months to 75 years, and of practically every variety of etiology and bacterial infection. I myself have had but 2 deaths, neither of which I believe was attributable to the treatment. I feel more and more with increasing experience that the method has much merit, and while it has its weak points and even its dangers, yet I believe it is applicable as generally as any other one method and especially so in very sick patients. So that judiciously used it should



Fig. 12. Inflatable bougie balloon of Morelli traversed by large drainage tube. Note smaller tube for inflation of balloon. These bougie balloons are made in different sizes and inflated sufficiently to give an airtight fit without undue compression of tissue. The balloon and tube are removable, a smaller one being used as the opening gets smaller.

lower the mortality of any one doing a large volume of this work.

I should like to see it more generally used and especially advise the most skeptical to use it as a preliminary measure to their own pet method. Many I am sure will be surprised by the results.

It may be interesting here to remark that Forlanini tried to treat his first two cases by aspiration without result. He later used aspiration with air replacement, getting complete emptying of the cavity and these first two cases were cured by this method. In the remaining cases he used it only as a preliminary measure followed by closed tube drainage and in his concluding remarks says that one should not lose time trying aspiration. I must also say that I was not familiar with these facts nor with the work of Elias until I looked up the literature in December 1930 in the preparation of my paper published in 1931 (3).

TECHNIQUE

Three methods are used to remove the contents of the empyema cavity and replace it with air.

1. In small effusions by puncture with a single large needle attached to a syringe.

2. In large effusions by puncture with a large and a small needle to which a suction apparatus and a pneumothorax apparatus are respectively attached.

3. Where the needles become blocked by temporary small intercostal incision with emptying of cavity by repeated forced inspiratory and expiratory effort.

In small effusions. The site and outline of the purulent effusion having been determined a point in the intercostal space corresponding to the lowest point of the empyema cavity is anesthetized with 0.5 or 1 per cent solution of procaine hydrochloride all the tissues from skin to pleura inclusive, being thoroughly infiltrated. A large needle is now attached by a stiff rubber tube connection to a 50 cubic centimeter Luer syringe and inserted at this point. A syringeful of pus is now aspirated the tube is clamped with hemostatic forceps, the syringe is disconnected, emptied, filled with an equal quantity of air and reconnected to the tube and needle the forceps are unclamped and the contained air is injected. This alternate aspiration of fluid and injection of air is repeated until, on aspiration air comes through the needle which shows that the needle point is now above the fluid line or that all fluid has been aspirated. The patient and needle are manipulated so as to make sure that the needle point rests in the bottom of the pus cavity and the procedure is repeated until air again comes from the needle, which indicates that no more fluid remains. This is preferably done with the patient sitting up, but very sick patients are treated lying down with the head and shoulders slightly elevated. It is essential that the connecting rubber tubing be very stiff as ordinary tubing will collapse with the amount of suction usually required when the pus is thick. The introduction of a large needle is much facilitated by making a small skin stab with a sharp pointed knife (Fig. 8). The needle attached to the clamped tubing may more conveniently be inserted before connecting with the syringe. (Fig. 9).

In large effusions. A second spot in the chest wall is infiltrated with the anesthetic solution and a second smaller needle is introduced. The first larger needle is connected to the suction apparatus and the second needle to some form of pneumothorax apparatus whereby the amount of air that comes through can be measured and the cavity rapidly emptied by simultaneous suction and air injection (Fig. 10).

When the aspirating needles are blocked. In some cases the fibrinous exudate prevents

complete emptying of the cavity by blocking even the largest needle, rendering it possible to aspirate, at most, only from one half to two-thirds of the contained pus. If delay is inadvisable, a small intercostal incision is made, just large enough to introduce the index finger, the patient is turned so that this incision lies at the most dependent part of the cavity, and he is instructed to perform repeated forced inspiration and expiration while a long pair of forceps keeps the incision open (Fig. 11) fluid being forced out with each expiration and air forced in with each inspiration, masses of fibrin being removed by the same forceps as they appear in the wound until the entire cavity is thoroughly emptied of fluid and free fibrinous masses. In children the crying efforts are utilized in the same way. If the patient becomes shocked or has a tendency to cough the wound is closed by digital pressure and the patient is immediately relieved. After a moment the procedure is continued as before. When the chest has been entirely emptied the patient takes a final deep inspiration at the end of which the lips of the wound are compressed digitally and kept so by a gauze compress. These wounds do not drain, they heal readily and have to be reopened if the procedure is to be repeated.

This last method may perhaps more readily appeal to many who seem so unreasonably prejudiced against aspiration. They can have as bloody a field as desired, can see the pus pour out, including fibrinous masses, and can reopen the wound at will.

In many of these cases there seems to be no reason to hurry and if one will have the patience to wait the fibrin will eventually liquefy. I have been on the point of making an incision in a number of these patients but after repeated aspirations without using anything intended as a solvent the contents finally became perfectly fluid and it was possible to empty the cavity entirely.

APPLICATION OF METHODS

Whichever of these three methods is used the volume of air replaced is usually the same as that of the fluid removed. It may, however, be varied as indicated. Thus if the cavity is refilling very fast so that more

fluid accumulates than the volume of air absorbed in the same period, less air is replaced, and *vice versa*. Negative pressure, if desired, may be produced by injecting as little air as desired. I have never deemed it advisable to do so. The air *per se* has no therapeutic value. It is merely used (a) to render possible evacuation of all the fluid, and (b) to replace completely the fluid and support the walls of the cavity as before.

Thus the architecture of the cavity, as it were, is not altered and the hydrostatic or rather the physical compression of the lung is undisturbed except that the heavy inelastic fluid mass is replaced by a light elastic air cushion. In the many hundred times that I have introduced the largest available needles into the pleural cavity, I have never witnessed the clinical syndrome spoken of as pleural shock. I believe that this is due to the pains taken to infiltrate thoroughly not only the skin proper but the pleura itself and all the intervening tissue with the anæsthetic solution. I have never used general anæsthesia. No drain, no suction or irrigation in any form is used.

The amount of pus removed may vary from a few cubic centimeters to as much as 3,000 cubic centimeters or more at one time. The procedure is repeated as often as the fluid accumulates, on an average of about every 6 days. The amount of reaccumulation between aspirations is seldom over 300 cubic centimeters and often less quite in contrast to the large quantities seen when tube drainage is used. Patients leave the operating table feeling relieved and, having had no discomfort during the procedure except for the infiltration of the local anæsthetic, willingly and cheerfully submit to subsequent aspirations.

The cavity has a tendency to get somewhat smaller as the condition improves, partly because of granulation and cicatrization in the angles of the cavity, and partly perhaps because the air is absorbed faster than the fluid reaccumulates so that one may find the diaphragm gradually rising, requiring insertion of the needle in a higher intercostal space at later sittings.

I believe that complete emptying of the cavity is essential to bringing about a cure.

One patient was cured with one aspiration. Some patients have had ten or more. The average has been about four. When the cavity has been entirely emptied the patient's temperature drops to normal in a few hours and he feels greatly improved and is able to eat and take an interest in things about him. If the aspiration or evacuation is not immediately followed by this improvement it means that the cavity has not been emptied or that the patient has another cavity or some other serious condition that is making him sick and a diligent effort must be made to find it.

My second patient had three separate cavities. The roentgenograms taken after partial emptying showing three separate fluid lines. These cavities communicated with one another and by rolling the patient first one way and then the other we were able to get the fluid from all cavities against one side of his chest wall and aspirate it. In some of these patients there are separate cavities that do not communicate with one another. In 1 case after quite a large cavity had been evacuated and the pus replaced with air the patient continued to have elevated temperature and to look sick. The roentgenograms showed a shadow and aspiration revealed another cavity above the one that had previously been emptied. This was treated the same way and she made an uninterrupted recovery. I have had 3 such cases, in 1 of which there were three separate cavities.

I have for some time adopted the practice of making a small stab in the skin at the site of needle puncture and I believe that this is one reason why I so seldom see a local pustule or abscess following exploration or aspiration. This little stab wound makes possible the introduction of the large needle which one must use without the pain and psychic trauma caused by trying to force such a large needle through unbroken skin.

In a number of cases for periods of as much as 5 and 6 weeks the cavities went on refilling. In spite of repeated aspirations with no improvement in the local signs or in the general condition of the patient. These were those in which the infecting focus in the lung continued to pour infection into the cavity. One was a

gunshot wound with a bronchial fistula. The cavity continued to refill until the fistula finally healed after which the patient's improvement was quite rapid. There is nothing to do in such a case but wait until the lesion heals or the bronchial fistula closes. If there be little or no air forced into the cavity through the fistula, and no tendency to tension pneumothorax healing can sometimes be encouraged by increasing the amount of air injected thus further compressing the lung and favoring the closure of an opening or cavity on its surface. If however there is already positive pressure resulting from coughing of air through the bronchial fistula into the cavity this must be relieved by frequent repeated aspiration of air. If the air re-accumulates rapidly with a tendency to displace lung and mediastinum a needle or trocar should be inserted and left *in situ* so as to permit the escape of air from the cavity as it accumulates. These patients must be watched very closely and seen often as death may result if a tension pneumothorax is permitted to progress without relief.

TREATMENT OF SPECIAL TYPES OF EMPYEMA

For the sake of emphasis and at the risk of some repetition I desire to say a few words about three particular types of empyema.

1. *When a large pre-existing pulmonary abscess or empyema pocket ruptures into the clean general pleural cavity.* The sudden rupture into the comparatively clean pleural cavity of the contents of a large fetid gangrenous abscess of the lung and to a lesser extent that of an empyema pocket is accompanied by profound shock and occasionally the patient dies before anything can be done for him. These lesions are analogous to similar ruptures into the peritoneal cavity. Aspiration or small tube closed drainage in any form is here out of the question. Immediate shock should be combated with morphine and cardiac stimulants, intravenous dextrose and transfusion if indicated. As soon as the patient improves sufficiently a wide opening with rib resection should be made at a point best calculated to secure drainage and the pleural cavity thoroughly emptied and cleansed. If necessary by introduction of a suction tip

into the more inaccessible portions. When the pleural cavity has been cleansed as well as possible, large tube drainage should be instituted with all the precautions against open pneumothorax already mentioned. The hour glass balloon of Morelli (Fig. 12) surrounding a large tube should answer the purpose well here, giving free drainage and hermetical sealing with protection of the raw surface of the incision by contact with the balloon.

2 *Pyopneumothorax* If before incision or exploratory puncture the physical signs and roentgenogram show the presence of fluid and air, one can be quite sure that a bronchial fistula exists. Two factors here complicate the picture: (a) The presence of a continued focus feeding the pus cavity, and (b) spontaneous pneumothorax air finding its way in through the fistula.

For some time to come, and until the fistula closes, the empyema cavity will continue to be fed with infection, and one must be prepared for a longer period of treatment than otherwise, no matter which method of treatment is adopted. *Prolonged* tube drainage in these cases promotes much granulation in the neighborhood of the tube, rendering the walls of that portion of the cavity correspondingly rigid. The entire pleural surface including its visceral layer becomes denser and less yielding as time goes on, so that when eventually the fistula does close, collapse of the cavity is much more difficult than in the more recent case. If the cavity at this stage does not communicate with the outside, as when aspiration and air replacement has been used, the negative force exerted as the remaining air is absorbed, is exerted principally on the lung surface itself. Being a gradual constant force, the soft tissues be they ever so firm gradually yield and the cavity is finally obliterated. If there has been tube drainage, there can be no collapse while the tube is in place, and even when the tube has been removed the negative pull is more apt to reopen the sinus than dislodge the lung, hence the greater tendency to chronic empyema. By the judicious use of aspiration and air replacement at this stage any fresh accumulation can be removed and sufficient air can be injected from time to time to give the desired gradual diminution in the

size of the cavity. Thus the pull on the lung is gradual and not strong enough to reopen the sinus or bronchial fistula. I have in this way cured at least 2 cases that had had repeated tube drainage.

In an older patient or one who is inclined to be very quiet especially in the absence of severe coughing spells, spontaneous pneumothorax may not be a serious complication. In children, and in nervous, restless individuals however, in whom coughing is easily incited and may come on in repeated violent spells, great quantities of air may be forced into the pleural cavity, a little with each coughing effort.

If aspiration or any method of closed drainage is used, the patient must be very carefully watched and frequently seen by the doctor treating the case, and the air permitted to escape if its volume grows large or if any sign of pressure or discomfort develops. This may be done by unclamping the tube where one has been inserted, or performing repeated aspiration if aspiration is being done or before drainage has been instituted. If the recumulation of air is rapid, a needle or trocar may be introduced and left in place for a few days. I know of at least one death caused by neglect to observe this precaution.

3 *Purulent mixed infection empyema, complicating pulmonary tuberculosis, or occurring as an incident to transpleural operations*. The former is a very grave condition. It is due to the rupture into the pleura of a cortical tuberculous cavity or abscess, and this lesion must heal or at least its opening into the pleura close before the empyema can be cured. Tube drainage is followed in a very large percentage of cases by chronic empyema. Even closed, small tube drainage is likely to do the same, especially if any form of suction is used, in which case the cortical lesion is thereby prevented from closing and reinfection of the pleura continuously favored and encouraged.

Aspiration with replacement of air is here the ideal treatment. The amount of air introduced may be increased to the amount thought most calculated to compress the lung sufficiently to favor the closure of the cortical lesion on its surface. If, however, this lesion happens to be in a stretched area of lung such

as in a band reaching from the chest wall to the collapsed lung then the more the lung is compressed the more the band becomes stretched and the more closure of any lesion in its substance is prevented. Hence it may become necessary to cut this band away from the chest wall before the empyema can be cured. One might use for this purpose the instrument of Jacobaeus that is used like an operating cystoscope. It is introduced through a large trocar or small stab wound and the band cut with a low power cautery. On the other hand the chest may be deliberately opened through a long intercostal incision and the band cut under direct vision. This seems a formidable procedure but my experience with 1 case (4) makes me inclined to feel that it should be done more frequently. This was a young man with an old fibrotic tuberculous process in the right lung with pyopneumothorax with mixed bacterial infection which resulted in a cure after repeated aspiration and air replacement before and after the incision of a band by open operation.

The intrapleural pneumolysis of Jacobaeus and the open treatment of these bands by free thoracotomy have been done in cases of pulmonary tuberculosis receiving artificial pneumothorax where these bands prevented the complete collapse of the lung. They are considered as somewhat serious procedures, however because of the possibility of the development of purulent mixed infection of the pleura. The same is true of all operative procedures on the lung even in non-tuberculous patients.

If the case just cited is to be taken as a guide and successful operation deemed possible in the presence of empyema, then the onset of an empyema after a transpleural operation should not appear as such a formidable complication. I believe this to be one of the most important uses to which the treatment by aspiration and air replacement will lend itself.

CONCLUSION

In favor of periodic evacuation and air replacement may be said

1 It can be used as a preliminary to any other method without harm.

2 It can be used when other methods have failed. I have done so in two instances.

3 It leaves no scar or deformity especially if a small stab is done before introducing a large needle.

4 Patient is not constantly bathed in pus, not encumbered with apparatus, is up and about most of the time.

5 Less danger of metastatic abscess. Boyd says this is practically impossible in an untraumatized pleura.

6 The cost of many dressings is saved.

7 Least probability of chronic empyema.

8 Least trauma greatest probability of minimum residual pleural adhesions.

9 With proper precaution should be safer and result in lower mortality than any other method.

10 It is especially valuable in the presence of pulmonary tuberculosis.

11 It lends itself admirably to rendering safer all operative procedures within or through the pleural cavity.

Against the method it may be said

1 It should not be used in sudden overwhelming infection of pleura by ruptured abscess, etc.

2 There is the danger of tension pneumothorax. This is I believe, its most serious objection.

3 Chest wall infection is possible. I have seen only one superficial abscess and very few pustules.

4 During the intervals between treatments a certain amount of pus is present, giving fever malaise, etc. This usually is only evident 1 or 2 days before the next treatment. The patient is practically well the remainder of the time.

5 It requires more frequent contact of surgeon with patient and more frequent re-examination and roentgenograms.

It is impossible to say all that may be said of empyema in any one article such as this. I have therefore, limited myself to a discussion of the truly clinical phenomena which the surgeon meets and must have in mind in treating the patient. Nothing is said of bacteriology and histological or microscopic changes. I have tried to avoid theory clinging as closely as possible to known facts.

I hope I have made it plain that the air replacement method combined with aspiration or with stab wound evacuation is not just another "new discovery aspiration treatment" It is not merely aspiration, it removes the pus and produces the same condition that results after tube or any other drainage that is, a clean cavity filled with air. The cavity is sealed, there is no strain on its walls and the more air present the longer it takes for absorption, and the more time the endothelial surface has to return to normal. It is not necessary therefore to presuppose that there should be any deviation from the normal process of healing in order to bring about a cure by this method.

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INFLAMMATION¹SIR GEORGE LENTHAL CHEATLE, K.C.B., C.V.O., F.R.C.S. *London*

AS a teacher I have always had great difficulty in making clear to the student what inflammation really is and where the process ends. Most writers on the subject seem to me to be in the same difficulty. Textbooks on pathology with the exception of Thoma either imply or state definitely that Burdon Sanderson's definition of inflammation is a true one. In 1872 (?) Burdon Sanderson laid down that "inflammation is the succession of changes occurring in a part as the result of injury provided that that injury be not so excessive as to destroy the vitality of the part. This definition has no time limit the nature of the injury is not specified and it includes events that were either well known or only just conceived at the time it was made. As the definition stands, it would include today processes of infection local and general immunity phagocytosis and the repair of damaged tissue. Even the incidence of certain benign neoplasms and of *sarcoma* and *carcinoma* could be included. It is so all inclusive that the common saying 'inflammation is the basis of all pathology' would apply. This application would be meaningless, as if it were said that biochemical or nutritional changes were the foundations of all pathological changes. Twenty years before Burdon Sanderson made his historical definition Lister published his classical investigation upon 'The early stages of inflammation which appeared in the Philosophical Transactions of the Royal Society in 1858. Lister conceived that inflammation is a pathological process, and he ended his researches in these words—'whenever in inflammation congestion or in other words, that disturbance of the circulation which is truly characteristic of inflammation exists in any degree the tissues of the affected part have experienced to a proportionate extent a temporary impairment of functional activity or vital change.

Before Lister John Hunter had conceived that inflammation was active in its nature,

and consisted in an exaltation of the affected parts, and that any increase of blood supply that might accrue to an inflamed part would necessarily induce an increased growth, or action of that part, and as a result induce the repair of damaged tissue.

Let me take these notions more in detail.

John Hunter transplanted cocks spurs into their combs. The result was that the spurs grew to enormous size a condition he put down to the greater power of action in the comb than in the leg. As a contributory cause of the excessive growth he said there was no stagnation of blood in the veins of the head.

Hunter also considered that the new blood vessels that are formed in newly extravasated and unliving substance in the healing of wounds stimulated healing by giving "power of action.

Turning to Hunter's transplantation experiment, some years ago I repeated it, and besides transplanting the spurs into the cocks combs, I transplanted them into the subcutaneous tissue of their necks. All these spurs grew to the same extent in the same time in their new situations, and all the growing spurs were provided with a special leash of blood vessels for their nourishment. The explanation of the excessive growth in the spur when transplanted in the comb cannot have been due to the greater vascularity of the comb or to the freedom of the venous return. The same amount of growth took place in the same time in the subcutaneous tissue of the birds' necks. In this plane of tissue there is very little blood supply compared with the normal cock's comb. Nor could the excessive growth in that part be due to its greater power of action than in the leg, unless the subcutaneous tissue of the neck also has a greater power of action. The great increase of size that occurred in the spur when transplanted into the comb and also into the subcutaneous tissue of the neck is capable of another explanation. In these new situations

the spurs were not subjected to the wear and tear of life to which they are exposed in their normal positions

It is difficult to see exactly what Hunter's experiment does prove. Biological laws of function, physiology, heredity and so forth are so interfered with by altering the normal position of a spur that the results of the experiment become too complicated to render an explanation possible without further evidence. For example, if Hunter were right in his conception that the spur grew to so large a size because the comb possessed greater power of action than the leg and because the venous return was more perfect the following question would naturally arise and demand an answer. How is it that a normal comb ceases to grow when it is in possession of so much 'power of action' as to be able to induce such enormous growth in another structure?

The reason of the increase of growth in the spurs when transplanted to this new situation is probably more complicated than the one I just now adduced although it may have some bearing on the matter.

I do not believe that Hunter's experiment can be explained by the spur being transplanted into a part where the blood supply is greater than in its normal position. The neck control experiment negatives that explanation. Nor do I believe that there is any evidence in support of the theory that an increase of blood supply will alone induce an increase in growth or an incitement to grow. The incidence and maintenance of normal growth of repair, and of neoplasms depend on many more factors than merely the increase or diminution of blood supply. Yet they may all have this in common viz that the accurate knowledge of what is occurring in one of these instances may have a great bearing on what is occurring in the remaining two.

Turning again to the observations of Lister on 'the early stages of inflammation,' in this paper Lister chiefly limits his observations to showing that an injured blood vessel is dilated to the state of temporary paralysis, that stasis occurs, that red and white blood corpuscles tend to adhere to each other and to the blood vessel walls. Further that the arrest of movement of the cilia of ciliated epithelium and the

cessation of movements of the pigment granules in pigment cells were proofs of impaired functions in the inflamed parts. So far as I am concerned with two additional factors, Lister's conception appears to me to be the essence of inflammation. The additional factors to which I have just alluded are the exudation of plasma and limited emigration of red and white blood corpuscles from the injured blood vessel walls. I cannot understand why Lister did not include these two factors in his description. Waller¹ in 1846 had described them, but no notice was taken of Waller's work until Cohnheim called renewed attention to it in 1867, 1869 and 1873. Exudation of plasma and emigration of red and white blood corpuscles occur *pari passu* with the other changes that Lister described and therefore necessarily should be included in early changes. In fact stasis of the corpuscles in an inflamed area is due to the escape of plasma from the injured blood vessel walls and emigration of red and white blood corpuscles has occurred before stasis takes place.

I did not know Lister until over thirty years after his work on inflammation. By this time his life was fully occupied in teaching the world the results of his epoch making and more recent discoveries. Having settled the matter that inflammation is a pathological process, he was disinclined to open the matter again and did not inform me of the nature of the events he would have included in an investigation into the late stages of inflammation. Lister's conception of inflammation with the addition of the immediate exudation of plasma and a limited emigration of red and white corpuscles, is from my point, the state of inflammation, and there, upon resolution of these changes, the process stops. Inflammation therefore, from my standpoint, forms only one of the effects that may occur after injury to a part. The nature, degree, and duration of the injury seem to me to induce much more vast and complicated events which should not be included in inflammation. These eventful changes in the parts injured may be entirely different from each other and affected and controlled by different problems,

¹London and Edinburgh Philosophical Magazine 1 vol. xlix, p. 307

while the process of inflammation as I have conceived it remains the same.

Still, I cannot imagine a more dramatic or descriptive term than that of 'inflammation' that was applied by prehistoric observers to a hot swollen red and painful part. Much water has passed under the bridges since the early ages prior to and including the first half of the nineteenth century. Infection and its consequences, immunity and infection, the normal growth of tissues, the repair of tissues and the formation of neoplasms have become separate problems, and yet they are being described at present in the one inextricable tangle of 'inflammation'.

The knowledge of these things, incomplete though it be, is so vast and so rapidly accumulating that I feel these facts alone demand their exclusion from the subject of inflammation and that a limit should be put to its action and influence.

I am fully aware that a great deal I have said is purely contentious and may be regarded as being entirely wrong. I admit that it represents only a personal opinion. Yet I believe I shall carry most pathologists with me when I say that the time has come to exclude repair and the formation of neoplasms of all kinds from the subject of inflammation. It is gradually dawning on mankind that they are under such definite and complete control of the body in some instances and under a disturbance of control in others, that they should not be considered under the head of inflammation. Directly one cell begins to divide into two cells a fresh element has been established and although it may be the effect of injury it is not necessarily the effect of inflammation.

Let me go more into detail by speaking of four subjects. The first (a) is repair of tissues, the second (b) is the formation of fibroadenomas of the breast, the third (c) is the formation of papillomas in the breast and the fourth (d) some local aspects of infection.

a. In the repair of tissues there is an example of organized and beautifully controlled growth. The control is so definite that the growth cannot be explained as being due only to the presence of growth stimulating agents induced by injury. If that were so tumor

formations would be expected rather than definite organized growth. There is also some thing more at the back of it all than the presence of hormones. Why should epithelial cells which have covered a raw surface cease to multiply on the instant the raw surface has been covered? No more complete control of growth can be imagined than that which is occurring in the tissues of a healing ulcer of the skin. Until it is covered by epithelium an enormous number of blood vessels are provided for the nourishment of the granulation tissue, but directly the ulcer has been covered by epithelium, these newly formed blood vessels begin to disappear and those that remain are only those that are sufficient in number to maintain the nourishment of the part. The co-ordination of the blood supply to the demands of growth and the subsequent maintenance of nourishment is perfectly timed and masterly in execution.

The repair of tissue does not depend upon a haphazard supply of blood vessels. Sufficient nourishment is supplied to meet the demand, and when that demand ceases the number of blood vessels which have become unnecessary spontaneously vanish. Even the formation of keloids is under some kind of control, which is in all probability local and systemic control.

By examining microscopically the fractured ribs of guinea pigs from the moment of injury to 36 days, I have been able to watch all the stages of a healing fracture. Besides learning a great deal more than I knew before, the prolonged and orderly sequence of events convinced me that they could not have been due to inflammation, or to the extractions of stimulating substance of growth due to the injury or to the uncontrolled action of hormones.

How can anybody maintain that so complicated and controlled an event as normal ossification is an inflammatory process?

I arrived at the same conclusions upon examining microscopically the common carotid arteries of cats from the moment they were ligated until 14 days afterward (Figs. 1 and 2).

In uninfected specimens the smallness in number of the emigrated leucocytes is sur-

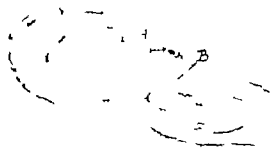


Fig 1

Fig 1 The carotid artery of a cat 7 days after ligation in continuity. A Seat of ligation. B the organizing blood clot at the site of the injured internal and middle coats of the artery. The shaft of the arrow B is passing through an area where the endothelial cells have gone and newly formed connective tissue can be seen growing from the subendothelial connective tissue into the organizing clot. C, The lumen of the artery.

Fig 2 The carotid artery of a cat 14 days after ligation in continuity. A Seat of ligation. B extensive hyperplasia

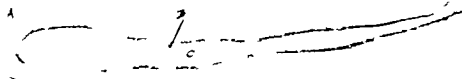


Fig 2

of the subendothelial connective tissue extending far along the course of the artery and diminishing the size of its lumen.

prising. The repair of the arterial coats that had been ruptured at the seat of ligation took place from the subendothelial connective tissue and not by multiplication of the endothelial cells. The only multiplication they underwent was in covering the newly formed connective tissue derived from the intima at this spot. Moreover the lumen of the artery at the end of 14 days had diminished by an increase of the connective tissue of the intima immediately beneath the endothelial lining which remained normal and not by the organization of a blood clot as I had previously supposed.

The formation of adhesions are good examples of purposeful growth of cells which appear to be carrying out inherited functions. In this connection I once had the opportunity of examining microscopically an excised bursa patellae that had suffered from injury unconnected by infective process. I excised the bursa 10 days after the injury. The inflammation induced an exudation of plasma within the bursal sac. The plasma coagulated and thus formed a mesh work of fibrin. Where the endothelial cells lining the bursa had been rubbed off, the branches of fibrin remained attached to the bursal wall and were contin-

uous with fibrin therein. These attached fibrinous branches became like hop-poles supports for the upgrowth of fibrous connective tissue cells which took along with them blood vessels for their nourishment. The formation of the adhesion was definitely finished by the covering of this growing connective tissue by a layer of endothelial cells continuous with those lining the bursal sac. The remains of the fibrin could still be seen in the centers of the young adhesions (Figs. 3 and 4).

b The neoplasias of the breast, known as fibro-adenomata, may at first appear to be growths that exhibit no control in their formation. The contrary is the fact. They are under some control that cannot be explained merely by inflammation to which their presence is so often imputed. There is often no sign of inflammation. Besides that the signs that are supposed to be indicative of "chronic mastitis" are present in almost every infant breast at birth, and I would not regard the condition as inflammation at all.

First, let me take the fibro-adenomata that appear at puberty. In their simplest states they are formed by precisely the same tissues that are undergoing physiological activity



Figs. 3, left, and 4. The two extremities of an adhesion in the course of its formation. In Figure 3, the fibrin at the base of the adhesion and its continuity into the wall of the bursal sac is well shown. Also the meshwork of fibrin with which the bursal sac was filled can be seen above the adhesion. The microscopical specimen was cut from a bursa patellae that had been injured 10 days before it was excised.

elsewhere in the same breast. New glandular elements of ducts and acini may be formed in these tumors and whether newly formed or not they are usually surrounded by dense layers of pericanalicular and periacinous connective tissues. It is this newly formed pericanalicular and periacinous connective tissue coming in contact with the supporting connective tissues of the breast that gives these tumors the macroscopical appearance of encapsulation. To classify all these perturbed physiological changes as being inflammatory does not seem to me to touch the problem of their existence.

Second let me take the intracanalicular fibro-adenomata, the connective tissue parts of which I have traced to the subepithelial connective tissue. These tumors occur later in life than those of puberty generally about the fourth or fifth decade. The glandular epithelium covering these tumors often dips down into the connective tissue element and forms perfectly developed normal looking acini, which any young breast would be proud to possess. Irregularly planned new breast tissue has been developed in these tumors, the formation of which is under some control even if it be an irregular control.

c. Next, let me take the formation of papillomata in the ducts of the breast. From

small beginnings of stalks of pericanalicular tissue containing the elastica which are covered by epithelium, these stalks coalesce and in many instances papillomata develop into duct tumors consisting of irregularly disposed ducts and acini. These tumors form another example of some disturbance of control and an aborted attempt to form new breast glandular tissue. Nothing can convince me that they are evidence of only inflammation or that inflammation has anything to do with their formation.

d. Lastly let me take evidence on these matters given by the morphological appearances in the subcutaneous tissues that have been inoculated with a culture of *Staphylococcus aureus*, sufficient in dosage and virulence to give rise to a localized abscess that ruptured in 7 days (Figs. 5, 6 and 7).

In this experiment I examined microscopically the whole of the affected area varying from the effects of the immediate inoculation to 10 days afterward. I have described them in detail in *Choyce's System of Surgery* and I need not here repeat them. The impressions I gained from a morphological study of these events were as follows:

1. The course and results of an infection depend primarily upon a balance or an adjustment between the resistance of the host and

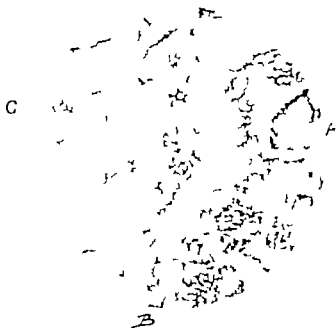


Fig. 5. Part of the margin of an acute staphylococcus abscess in the subcutaneous tissue of a guinea pig 4 days after inoculation. B the center of the abscess the edge of the abscess which in some parts is in contact with the strands of fibrous connective tissue that has already undergone hyperplasia while at others the abscess is still spreading among fat cells C the strands of fibrous connective tissue that are undergoing hyperplasia at some distance from the edge of the abscess

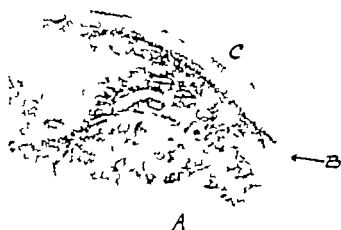


Fig. 6. Part of the margin of the same abscess. The oval and circular spaces are newly formed blood vessels in a line with the arrow B and are situated at the edge of the abscess in the newly formed connective tissue there situated C a strand of fibrous connective tissue that has undergone hyperplasia.

chiefly the virulence of the micro-organisms at the actual moment of infection

For example take the rapid death of a host from a generalization of the infection. Here either the resistance of the host is so low or the degree of virulence of the micro-organism is so high, that no time is allowed for the formation of an acute abscess. Hence when an acute abscess forms it can be accounted for only by the existence of an adjustment between the powers of resistance of the host and the degree of attack on the part of the micro-organism

During the course of even the formation of an acute abscess the process of the host's resistance may become lowered or the virulence of the micro-organism may become increased yet my opening statement remains a sound one. The whole process first of all depends upon the degree of adjustment of factors of host and micro-organism at time of infection.

Again the first thing that occurs in the formation of an acute abscess is the death of tissue with which the infecting agents come into contact

The next thing that is obvious is the tremendous emigration of polynuclear leucocytes most of which are at first killed. However the process of emigration of leucocytes continues

The third and fourth events are the emigration of lymphocytes and the hyperplasia of the normal strands of fibrous connective tissues that support the subcutaneous fat. These events occur immediately around the developing abscess and by the fourth day they are well established. I do not know whether the inducement of emigration of the leucocytes is the same in a suppurating process as it is in the stage of inflammation due to mechanical injury. If the inducing agents be the same in both processes then it could be claimed that inflammation is a great factor in suppurating.

If however the inducement of the leucocytes to emigrate in a suppurating process be not the same as in inflammation produced by mechanical injury then not in inflammation but some other process is in operation. I doubt very much whether the factors that induce the emigration of leucocytes are the same in infective and non-infective lesions.

The bone marrow in which the enormous increase of polynuclear leucocytes is manufactured, is not in a state of inflammation. In fact, the whole of this part in the formation of an acute abscess may be considered as being

A

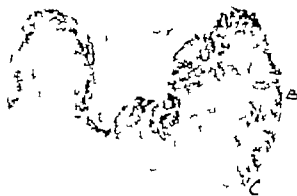


Fig. 7 Part of the margin of an acute abscess (*Staphylococcus aureus*) stained by Gram's method, 7 days after inoculation. A The center of the lesion B the marginal ring of massed staphylococci encircling the edge of the abscess C the surrounding subcutaneous fat and connective tissue.

questions of immunity rather than being concerned with the process of inflammation. Micro-organisms at first multiply and are mixed with no arrangement in the lesion. By the seventh day a very definite arrangement has occurred in which a dense mass of micro-

organisms completely encircles the abscess cavity in the form of a ring. The ring of micro-organisms is situated at the extreme edge of the abscess beyond which none can be seen. It is impossible to explain the meaning of this ring beyond suggesting it has something to do with the question of immunity (Fig. 7).

Turning to the later events such as the hyperplasia of the normal supporting strands of connective tissue during the process of formation of an acute abscess here again the establishment of immunity transcends in importance any concurrent process of inflammation that there may be.

The hyperplasia of connective tissue that takes place around an abscess could not occur if the micro-organisms were able still to cause the death of tissue they manifested on their first introduction.

An abscess does not get well and does not become localized because it is encysted by an abscess wall. Even when the abscess has been opened and the lesion is getting well, pus can still be seen in tissues where there is no limiting wall.

These observations definitely show that infection and immunity and not inflammation are the important factors the body is concerned with in the formation and cure of an acute abscess.

THE DETECTION OF THE CLINICALLY LATENT CANCER OF THE CERVIX

WITH A REPORT ON SCHILLER'S LUGOL TEST¹

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THE treatment of cervical cancer is at the present time entering upon a new and more hopeful phase made possible by fresh scientific knowledge both of malignant disease in general and of that particular aspect of it that forms the subject of this paper.

The combat against cervical cancer during the last 30 years has accomplished much. The formidable operations of Wertheim and Schauta which demonstrated the possibility of permanently curing the disease have given way for the most part to the simpler and more efficacious methods of radiation. Elaborate follow up studies of treated cases have formulated the percentage of permanent cures to be expected relative to certain stages of progress of the disease. The total number of cured cases though not large enough appreciably to affect the general mortality statistics, is nevertheless encouraging. It has at least established a fact of prime importance, namely that cancer of the cervix is frequently cured by the means at our disposal, the chances of cure being directly proportional to the timeliness of the attack.

The logical conclusion is that every cancer of the cervix passes through a period in its life history during which it is theoretically one hundred per cent curable. This is the rock on which the hope of controlling the disease is at the present time based. Ultimate success depends on the co-ordinated efforts of every member of the profession who treats women at all to detect and bring to treatment the early case.

Now for the past 30 years we have all been studying and treating cervical cancer in its advanced stages. All clinical and pathological characteristics with which we are so familiar are those of advanced cancer. The standard symptoms of fetid discharge, bleeding, pain, the local changes of tumor formation, metastasis and ulceration, the histological picture of

invasion and multiplication of cells, all are manifestations of comparatively late stages of the disease. The great array of tables portraying the percentages of mortality, recurrence and cure represents almost exclusively the treatment of advanced cancer. The division of cervical cancer topographically is merely an inaccurate estimate of the degree of progress in an already protracted disease.

It is difficult to realize how few incipient cancers of the cervix have until recently ever been detected and consciously treated. Only the merest handful have been reported in the literature, the discovery of such a case being usually by pure accident and hailed triumphantly as the rarest of finds. And yet since the incidence of incipient and terminal cancer is identical, patients must repeatedly be on our examining tables who without impairment of health and often without symptoms harbor a disease which at the same time is invisible to the keenest eye and intangible to the most sensitive touch.

The treatment of advanced cervical cancer has actually reached an *impasse*. Surgery has attained its peak of usefulness. The limitations of radium are already in sight. Follow up records are now a necessary routine of the clinic but can teach us little that is new concerning the results of treatment along the old lines. The hope of diagnostic immunizing and curative sera must probably be abandoned in the face of scientific evidence that cancer is primarily a local and not a constitutional disease. Metals in colloidal form have proved disappointing since they are too destructive to the normal tissues. In view of the amazing effects of radium we look instinctively to the scientists to discover some new form of radiation in which the human body may be bathed and harmlessly cleansed of all malignant tendencies, an idea not entirely chimerical but certainly at the present moment utopian.



Fig. 1 Photomicrograph showing the abrupt change from normal to cancerous epithelium. The line of demarcation is always oblique since the change takes place in the cells of the basal layer first. The process is therefore further advanced in the lower than in the upper cells. On the left of the line are seen the well ordered layers of the normal epithelium. On the right are seen the dark atypical cells of the cancer. The interpapillary plugs are irregular and clotted but there is no elevation on the surface nor invasion of cancer cells in the stroma. Note the dense inflammatory infiltration beneath the cancerous portion. The disease is progressing from right to left by assimilation like ink on blotting paper. Taken from Schiller (5, p. 352).

In the search for the early case it must first be recognized that the life history of a cervical cancer covers on an average from 10 to 12 or more years. This includes a long irritative stage of chronic *cervicitis* and a shorter though still protracted period of *clinical latency* during which the cancerous change though actually present does not attract the attention of the patient or her attendant.

Until recently our best means of discovering cervical cancer in its latent stage has been the policy of timely repair of the inflamed cervix with a routine biopsy of the tissues. Many unsuspected cancers may be discovered in this way. But this policy has not been sufficiently widely adopted and there is still an unaccountable reluctance to repair dangerous *cervicitis* until the age of child bearing is passed. Even when rigidly carried out the system has been open to frequent error. The pathologist unfamiliar with the incipient cancer-changes may miss the diagnosis. Or the operator with nothing to guide him may

miss the cancerous area entirely in removing tissue for biopsy.

In recent times the invention of the colposcope by Hinselmann has been a laudable move in the right direction. But the instrument is expensive requires expert manipulation and is not well adapted to the use of the general practitioner.

In order to meet the difficulties of the situation it is evident that two things are primarily needed first a clearer knowledge of the histological appearance of an early cancer and second some simple test by which the latent area may be accurately located for purpose of biopsy. In the efforts to solve these two fundamental problems the work of Walter Schiller of Vienna stands pre-eminent and has been taken as a basis for this report.

Schiller approached the matter by first studying exhaustively the cervixes of 135 uteri that had been removed by total hysterectomy for causes other than cancer. Cancer itself being unsuspected. In this series of specimens he found 4 cases (2.96 per cent) with microscopic evidence of what he regarded as the earliest stages of cervical cancer. His observations and conclusions from this study harmonize closely with those of other authorities working in the same field and may be summarized as follows:



Fig. 2 Change from normal to cancerous epithelium. Note the oblique line of demarcation. There is clotting of the interpapillary plugs, but no elevation or invasion of the cancerous epithelium. (Taken from Schiller.)

Under the stimulation of chronic irritation the cancer process in a manner unknown starts in a single indifferent cell of the basal layer of the epidermis of the portio vaginalis. As has been shown by Carrel Loeb and others the malignant cell at first produces a virus that is capable of inciting malignancy in neighboring normal cells. This process is called *assimilation* and is the first stage of malignancy in cervical cancer. During this stage the growth extends laterally like the spread of a drop of ink on blotting paper. There is at first no thickening or change of consistency in the epidermis so that the affected area cannot be distinguished by sight or touch from the surrounding normal tissue.

A cancerous process thus inaugurated never heals spontaneously but progresses inexorably to what may be called the late stage that of invasion. The cancer now extends by a new force namely by the *multiplication* of its own cells which is so irresistible that it invades and destroys the neighboring tissues. Here we have the late cancer with which we are all so familiar—the nodular thickening, the ulceration and metastasis, the infection, necrosis and fetid discharge and the bleeding from broken or eroded vessels.

The histological picture of an early cancer in the assimilation stage is striking and



Fig. 4. Case of early unsuspected cancer discovered at the Free Hospital for Women by routine biopsy after trachelorrhaphy. Note the oblique line of demarcation, and the intense inflammatory infiltration beneath the cancerous area. Note also that there is no invasion of the stroma and that the cancerous strip of epithelium is actually thinner than the normal portion. The two dark spots in the normal epithelium are not cancer but the tips of papillae in cross section. (Pemberton and Smith.)

characteristic. Most prominent is an abrupt demarcation between the normal epidermis and the cancer, which always appears as an oblique line. On the one side are the normal epidermoid cells in their well ordered three layer arrangement, on the other side are the dark and stormy cells of the cancer with a blurred or broken basal line, above which appears a confusion of cells irregular in size, form and staining properties and with little or no evidence of differentiation and layer building. All the other signs of cancer are seen *excepting that of invasion of the stroma* and when this is present the disease is *ipso facto* in the second or advanced stage. Without enumerating the finer details of the picture we may thus recapitulate Schiller's conclusions:

1. Cancer of the cervix starts in the squamous epithelium of the portio near the os and at first spreads laterally, i.e., superficially.

2. It always starts in the unbroken epithelium and not in an ulceration.

3. Histologically the chief determining points of diagnosis are first the oblique line of demarcation between the normal and abnormal areas, and second, the anaplastic atypia and polymorpha of the abnormal cells.



Fig. 5. Abrupt change from normal to cancerous epithelium. In this case there appears on the right a beginning of invasion of the stroma but there is no elevation of the surface. (Taken from Schiller.)



Fig. 5.

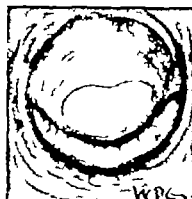


Fig. 6.



Fig. 7.

Fig. 5 Lugol test. Lacerated hypertrophied cervix. Cancer absent. The normal epithelium of the portio and vagina stains a dark, almost black mahogany color. The everted mucous membrane of the endocervix does not take the stain and appears light red or pink.

Fig. 6 Lugol test. Cancer present. The drawing is from one of the author's cases, and shows the normal tissue taking the dark stain. On the anterior lip is seen a patch of cancer revealed by the Lugol test, where the stain does not take, leaving the area almost white and sharply delineated from the normal tissue. In this case the disease had already reached the multiplication stage as shown by biopsy but

was still sufficiently early to warrant a favorable prognosis for radium or operative treatment. Radium treatment was used.

Fig. 7 Lugol test. Chronic cervicitis. Cancer absent. Drawn from one of the author's cases. On the posterior lip was a light patch very slightly tinged with brown. The edges of the area blended with the color of the normal background instead of being sharply defined from it as in cancer. Biopsy showed an intense cervicitis with some loss of epithelium in the upper layers. On the anterior lip are several Nabothian cysts, which often take a deficient stain on the surface.

But this histological revelation of the earliest appearances of cancer would be of little practical value without the ability to discover the location of a process not distinguishable by eye or touch. To meet this difficulty Schiller has devised an ingenious test which bids fair to be of general clinical value.

The test is based on the discovery by Lahm that the upper layers of the normal epithelium of the portio and vagina contain rich masses of glycogen which disappear when the epithelium becomes cornified or changed by cancer. In the normal living tissue the glycogen of the upper layers of cells is stained in a few seconds a deep mahogany brown by iodine in watery solution (Lugol's). A superficial area of early cancer being devoid of glycogen does not receive the stain and stands out startlingly white or pink against the deeply colored almost black background of the normal tissue.

I can best present the clinical value of this test by describing my own experience with it. I began using it about 9 months ago with half-skeptical curiosity but soon adopted it as a routine procedure on all cervixes in the

operating room and to some extent in office examinations.

During the period 3 early cases have been encountered which in respect to the Lugol test and the microscopic findings correspond to Schiller's dicta. In each case there had been suspicious contact bleeding so that the cases were not as early as some described by Schiller in which the discovery of cancer was made out of an entirely clear sky. However in all of these cases there was no tactile or visual evidence of cancer and in making the biopsy there was no guide to the location of the cancer excepting that of the Lugol test. Without it the specimens for examination would have been removed at random and the diagnosis of cancer might readily have been missed.

Schiller, in 553 clinical tests, found it positive (i.e. stain deficient) in 140 cases, 19 of them showing early cancer.

The test, simple as it seems, is not without its limitations. It appears to be completely reliable when it is clinically negative, that is to say when all the tissues take the normal stain. This claim made by Schiller has been repeatedly confirmed by our own biopsies.

The test is therefore specific for determining the absence of cancer of the portio and vagina. This of itself is an inestimable aid.

But there are several conditions that obscure the test and with these the examiner should be thoroughly familiar.

1 The stain does not take on glandular epithelium like that of the endocervix. Hence an eversion (ectropion) would appear pink. The same is true of the epithelium of an adenocarcinoma, so that this type of cervical cancer must be sought for in the usual manner. Fortunately such cancer is rare.

2 Ulcerations and erosions do not take the stain since they have no epithelial covering.

3 In areas of chronic cervicitis the epithelium seems often to be deficient in glycogen, taking a very light brown which blends with the surrounding deeply staining tissue instead of being sharply defined from it as in cases of true cancer. We now, after the biopsy, dissect off the suspicious area and close the wound with fine catgut.

4 The normal stain is prevented or obscured by slight trauma such as that from tenaculum or scrubbing with gauze. This is caused by the rubbing off of the upper layers of epithelium in which the glycogen is chiefly deposited.

5 The cervix and vagina of the hypoplastic and atrophic individual stains lighter than the normal. It is especially deep during pregnancy.

6 Pus stains black since leucocytes are rich in glycogen. Necrotic tissue also stains black but clean living granulations do not take the stain. A film of mucus prevents the stain. Blood and douche water obscure the reaction.

7 Hyperkeratosis prevents the stain as in leucoplakia, lues, and exposed areas in prolapse.

8 The test is of limited value in diagnosing advanced cancer, since the superficial assimilation stage is usually lost in the mêlée of self reproducing cells. Sometimes superficial areas detectable by the Lugol test may be found beyond the border of the advanced cancer especially in the fornices of the vagina and this may serve as a guide in determining

the limits for a radical operation. Cancer cells in the advanced stage may regain glycogen and thus give a dark stain with the Lugol's solution. Normal epithelium lying above an invading cancer takes a normal stain as would be expected.

9 Schiller's test is specific for cervical cancer, and is not adapted to other superficial cancers such as those of the vulva and skin in other parts of the body. This is due to the fact that the normal epidermis of the portio and vagina is not cornified and that the upper layers of cells contain a special chemical type of glycogen.

Application. The writer's technique is as follows. A thick swab of absorbent cotton and gauze is prepared on the end of a stout wooden applicator. The swab is first immersed in the Lugol's solution until a copious amount of it has been absorbed. With the upper vagina well exposed by speculum or retractors the swab is then pressed firmly against the anterior lip of the cervix. The upper vagina is in this way flooded with the solution which instantaneously stains the normal tissues (excepting the mucous membrane of the endocervix) almost black. Any area of the portio no matter how small that does not take the stain must be regarded with suspicion. The suspicious area is then curetted with a specially sharpened spoon curette. The strip of epidermis thus secured is placed immediately in hardening solution and sent to the laboratory for biopsy.

CONCLUSIONS

We are finding the Schiller test an indispensable aid in the search for early curable cancer of the cervix. It is specific for the absence of cancer. Failure of the stain indicates certain other abnormal conditions two of which, leucoplakia and intensive cervicitis, are potential precursors of cancer and require treatment. We recommend the test for trial to the general profession.

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THE RESULTS OF RADIUM TREATMENT IN FUNCTIONAL UTERINE BLEEDING¹

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FROM January, 1920 to July, 1932, 423 cases of functional uterine bleeding were admitted to the Gynecological Department of the University Hospital. Three hundred and ninety-one were given radium treatment and of these complete data regarding its effects upon bleeding are available in 344 and upon menopausal reactions in 336. In all the bleeding was so profuse or prolonged as to demand surgical measures for its control; no organic lesion in the pelvis could be found to explain the bleeding and there were no evidences of a causative constitutional disease, blood dyscrasia, or thyroid dysfunction. A large proportion had received no benefit from medical measures and in 73 the bleeding had persisted after some form of surgical treatment. Fifty-two patients had been curetted, some as many as five times, usually with no benefit or at most relief of from 1 to 6 months duration. None of the patients had received the present day hormonal therapy since the period of observation antedated the availability of these preparations. Doubtless a certain number would have responded favorably to it but our experience has shown that it is by no means a panacea and that at least 50 per cent will require some other form of treatment. Examination under anesthesia and microscopic study of the endometrium were invariably made.

Our experience with radium dates back to 1913 when Dr. John G. Clark began its use

In his clinic and we gratefully acknowledge our indebtedness to him for many of the principles which continue to guide us in this work. As the result of this experience we are convinced of the value of radium in the treatment of benign uterine hemorrhage whether of neoplastic or functional origin but by the same token this experience has enabled us to appreciate its limitations and has engendered a profound respect for its harmful potentialities when injudiciously applied. Accuracy of diagnosis, an understanding of the effects produced by radium in healthy and diseased structures as well as upon ovarian function, the ability to determine what lesions are amenable to irradiation and careful attention to the technique of application are the essentials of successful radium therapy. When these qualifications are met the results are on the whole satisfactory and complications are reduced almost to the vanishing point under other circumstances undesirable sequelae are sure to occur.

Much of the adverse criticism of radium is due to its abuse rather than to its use but even in the hands of those skilled in gynecological diagnosis and familiar with the effects of irradiation unsatisfactory results are encountered. The cure of functional bleeding by radium is accomplished by its effects upon ovarian function, cessation of which may result in the profound and often lasting disturbances which characterize the induced

menopause. For this reason radium should be used only when more conservative measures have failed and then with due regard to its limitations and dangers.

Although radium therapy was the procedure of choice in 92 per cent of the 423 patients, we believe that hysterectomy and roentgen therapy have a place in the treatment of functional bleeding. Radium is preferable to roentgen therapy because its dosage can be more accurately regulated; further completion of the treatment can be accomplished at the time of diagnostic curettage which should precede either form of irradiation. Hysterectomy or roentgen therapy are chosen when radium has failed or some condition is present which contraindicates its use; the choice of the one or the other depending in large measure upon the age or nervous stability of the patient.

The absence of both intermenstrual pain and acquired dysmenorrhea is a characteristic feature of functional bleeding. When pain is associated with irregular bleeding some organic pelvic lesion is usually present even though examination fails to reveal it and operation is preferable to radium therapy. With surprising frequency the wisdom of this decision will be proved when the abdomen is opened.

Radium should be employed with caution if at all, in patients who have had a previous pelvic operation since an intestinal loop adherent to the uterus may be seriously damaged by the rays. In a few instances we have used heavily filtered radium in small dosage successfully but we prefer operation or roentgen therapy.

Patients with profound anemia react poorly to both radium and roentgen therapy and irradiation of either form should be withheld until the blood has been improved by transfusion and other appropriate treatment. In deed, blood transfusion may be a curative measure, as we have had occasion to observe in a few cases of adolescent hemorrhage.

Our confidence in curettage as a therapeutic measure is in direct proportion to the 3 per cent incidence of its use in this series. However it, too, has a place in the treatment of functional bleeding particularly in girls and

young women when one may hesitate to use radium. At least a few will be temporarily benefited or cured. Even though the results be disappointing so far as bleeding is concerned the procedure is not entirely futile since valuable data will be afforded by a study of the endometrium thus obtained.

An attempt to estimate what has been accomplished by radium therapy must take into consideration not only the control of bleeding but also the manifestations of disturbed ovarian function which have arisen incident to its use. The criteria of success or failure vary in accordance with the age of the patient. In young women success is measured in terms of normal menstruation and preservation of the reproductive function, while in women approaching the menopause, the treatment is often a success even when complete cessation of these functional activities occurs. The frequency with which this differentiation must be made is evidenced by the fact that 50 per cent of the patients in the group studied were under 40 years of age. We have approached the problem of evaluating our results with these standards as our guide. The incidence of control of bleeding, permanent amenorrhea, and severe menopausal reactions is the yard stick by which these results are measured.

Throughout this study, we have determined the results from the standpoint of age groups and Table I gives a summary of the percentage of patients in each decade who received a given dosage of radium. According to our present belief, an initial dosage of between 400 and 500 milligram hours in the group under 30 is high nor would we give between 800 and 1200 milligram hours to nearly one fifth of the patients between 30 and 40. During this study, it was our custom gradually to increase the dosage with increase in age and the incidence of 46 per cent shown in the third age group who received between 400 and 500 milligram hours is explained by the fact that the age of the majority of the patients approached the end of the decade. Taken as a whole, comparatively small dosage characterizes this table.

The analysis of dosage outlined in Table I is based on that given at the initial treatment

TABLE I.—DOSAGE OF RADIUM IN RELATIONSHIP TO AGE IN THREE HUNDRED AND NINETY-ONE PATIENTS

Age in years	Kilohr per patient	100-200 mgm. hrs. per cent.	200-300 mgm. hrs. per cent.	300-400 mgm. hrs. per cent.	400-500 mgm. hrs. per cent.	500-1,000 mgm. hrs. per cent.
Less than 20		64	35			
20 to 29	84	78	14			
30 to 39	97	5	46			6
40 to 49	143		9	43	48	
50 to 59	30			43	67	

only and the results of this dosage are presented under the first portion of Table II. Under the heading of bleeding controlled are included both return of normal menstruation and permanent amenorrhea, hence a second heading was chosen in order to demonstrate the incidence of the latter condition. As would be expected, the highest percentage of those requiring subsequent treatment is found in the youngest age group and this decreases progressively to 8 per cent in those over 40 years. The last portion of Table II summarizes the final results obtained from both the initial and subsequent treatments.

This analysis forcibly confirms the statement previously made that conclusions as to the value of radium therapy must be based not upon the control of bleeding alone but also upon the incidence of amenorrhea in women under 40 years and severe menopausal reactions at any age. Could we construct an ideal method of treating functional hemorrhage it would have for its results return of normal menstruation and absence of menopausal symptoms in women under 40 and either amenorrhea or normal periods without severe menopausal reactions beyond this age. This Utopian concept can of course, never be realized but it gives us a standard by which to measure our results. Applying this measure of perfection we find that it comes nearest to accomplishment at the two extremes of the menstrual life. Between 30 and 40 years when preservation of ovarian function is desirable control of bleeding is but 5 per cent short of the ideal but in one-fourth of these, control was in the form of permanent amenorrhea. Further one-fifth

TABLE II.—SUMMARY OF RESULTS WITH THE PATIENTS GROUPED ACCORDING TO AGE

		Less than 20 years, per cent.	20 to 29 years, per cent.	30 to 39 years, per cent.	40 to 49 years, per cent.	50 to 59 years, per cent.
Results of Initial Treatment	Bleeding controlled	82	79	99	93	97
	Permanent amenorrhea	6		34	76	53
	Severe menopause		4	19	30	3
	Patients requiring subsequent treatment					
		47	20	19	8	8
Final result	Bleeding controlled	86	86	95	99	100
	Permanent amenorrhea	6		34	77	53
	Severe menopause	6	3		31	3

of these patients developed severe menopausal symptoms. During the fifth decade of life the ideal is practically accomplished in so far as the control of bleeding is concerned, but at the cost of severe menopausal reactions in a third of the patients. These distressing and often deplorable symptoms of disturbed ovarian function cannot be ignored.

Table III has been prepared to show not only the incidence of temporary and permanent amenorrhea during the different age groups, but also the results of varying radium dosage in each decade. Irrespective of age or dosage no group was immune to a temporary amenorrhea averaging 5 months in duration and in no group did a permanent amenorrhea develop after a dosage of between 200 and 300 milligram hours. With the exception of the 20 to 30 year group the incidence of permanent amenorrhea increases directly with the radium dosage as would be expected. The generally recognized fact that resistance to the action of radium decreases as the age increases is nicely shown in the 400-500 milligram hour group the exception being the group under twenty. Here an incidence of 63 per cent temporary and a 12 per cent permanent amenorrhea may be of no significance since only 8 patients compose it. However it suggests an increased susceptibility to irradiation as compared with that in women in the next decade. From this analysis it would seem that the ovaries in women between 20

TABLE III — DEVELOPMENT OF TEMPORARY AMENORRHEA (T) AND PERMANENT AMENORRHEA (P) FOLLOWING IRRADIATION IN 344 PATIENTS

The Temporary Amenorrhea Varied Between 3 to 12 Months with an Average of 5 Months

Age in years	1 to 100 mgm. hrs., per cent		4 to 100 mgm. hrs., per cent		6 to 100 mgm. hrs., per cent		8 to 100 mgm. hrs., per cent	
	T	P	T	P	T	P	T	P
Less than 20	11	0	63	1	None treated		None treated	
20 to 30	10	0	47	0	None treated		100 (1 patient)	
30 to 40	20	0	40	12	56	22	40	50
40 to 50	None treated		12	57	20	6	2	61
50 to 60	None treated		None treated		22	77	1	90

and 30 are highly resistant to radium or possess a strong recuperative power, since a permanent amenorrhea did not develop in a single instance, despite the fact that one patient received 1200 milligram hours. In the next decade, permanent amenorrhea is noted in 12 per cent, while in the 40 to 50 year group, the incidence rises to 57 per cent after the same dosage which gave none between 20 and 30. The increasing susceptibility to radium after 30 has an important bearing upon initial dosage and will be referred to later.

Table IV shows the incidence of menopausal symptoms, both mild and severe, which developed in the various age groups after the initial dosage summarized in Table I. Although no group escaped the mild reactions, these were for the most part transient and cannot be considered an objectionable feature of the treatment. On the other hand, severe menopausal symptoms are noted in all groups except those under 20, rising to a 30 per cent incidence between 40 and 50. The group between 50 and 60 received the largest average dosage, yet severe symptoms occurred in only 3 per cent. A factor, which contributes to the incidence of severe menopausal symptoms, is the patient's unstable nervous mechanism. The more nervous the individual, the greater is the likelihood of a stormy menopause even under normal conditions and when induced by irradiation the severity is multiplied. Bitter experience has taught us that this type of woman is ill adapted to radium therapy and

TABLE IV — DEVELOPMENT OF MENOPAUSAL SYMPTOMS FOLLOWING IRRADIATION IN 336 PATIENTS

Relationship Between the Severity of the Symptoms and the Patients Age

	Less than 20 years, per cent	20-30 years, per cent	30-40 years, per cent	40-50 years, per cent	50-60 years, per cent
Severe	0	4	10	10	3
Mild	12	14	5	25	41
Total	22	22	16	35	45

that hysterectomy with ovarian conservation should be chosen in its stead.

The incidence of severe menopausal symptoms, which have followed variations in radium dosage during each decade, is presented in Table V. In general our analysis shows that the percentage of these reactions increases with the dosage and this fact is well illustrated in the 30 to 40 year group which reaches the peak of 47 per cent with what is generally recognized as the menopausal dose. Exceptions are noted in the 20 to 30 and 40 to 50 year groups. Individual variations in the reaction to radium are well recognized and increased susceptibility may afford the explanation of these exceptions. Reference to the last two groups of the table shows that with a given dosage of radium, severe menopausal symptoms decrease with each decade until between 50 and 60 they are almost negligible. This is in direct contrast with the occurrence of permanent amenorrhea and it has an important bearing on the determination of initial dosage in patients over 40 years of age when a combination of amenorrhea and a low incidence of severe menopausal symptoms approaches the ideal result.

At the beginning of this discussion, the assertion was made that control of bleeding is not the sole standard by which the value of radium therapy is measured, but that consideration must also be given to the incidence of permanent amenorrhea and severe menopausal symptoms which may develop from the treatment. The associated incidence of these three factors with varied radium dosage during the different decades is shown in the following tables. The results given are those of the initial dosage only.

TABLE V—THE RELATIONSHIP BETWEEN THE AGE THE DOSAGE AND THE DEVELOPMENT OF SEVERE MENOPAUSAL SYMPTOMS

Age in years	10 to 200 mgm. hrs. per cent	4 to 700 mgm. hrs. per cent	4 to 700 mgm. hrs. per cent	8 to 1200 mgm. hrs. per cent
Less than 20			None treated	None treated
20 to 30			None treated	
30 to 40		7		47
40 to 50	None treated	1	8	10
50 to 60	None treated	None treated		8

The group of 17 patients under 30 was about equally divided between the two dosages given (Table VI). Although the incidence of temporary amenorrhoea was high with the larger dosage only one patient developed permanent amenorrhoea and the bleeding was not controlled in approximately half of them.

Between 20 and 30 years of age menstruation was restored to normal in a much higher percentage (Table VII). Permanent amenorrhoea did not develop but an incidence of 4 per cent severe menopausal symptoms is noted with the smaller dosage. The isolated instances of permanent amenorrhoea without menopausal symptoms and severe menopausal symptoms without amenorrhoea exemplify the individual and unexplainable reactions which may follow irradiation.

Table VIII is particularly interesting because in this 30 to 40 year group an opportunity is afforded to demonstrate the effects produced by variation in radium dosage as well as to support our contention that evaluation of radium therapy must be made in terms of permanent amenorrhoea and severe menopausal symptoms as well as control of bleeding. The results are on the whole satisfactory in so far as the control of bleeding is concerned but with the exception of those obtained from the minimal dosage the toll exacted by permanent amenorrhoea and severe menopausal symptoms has been high. At an age when the preservation of ovarian function is of vital importance such results cannot be considered successful irrespective of what the effect on bleeding has been.

The group between 40 and 50 comprises 147 patients. Permanent amenorrhoea is a de-

TABLE VI—ANALYSIS OF THE LESS THAN 20 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgm. hrs.	Bleeding controlled, per cent	Permanent amenorrhoea, per cent	Severe menopausal symptoms
0-200	55		
4-700	30		

sirable result during the fifth decade and we find that with a dosage as small as 400 to 500 milligram hours it has occurred in 57 per cent and the bleeding has been satisfactorily controlled in 86 per cent. Practically the same figures obtain with increased dosage until we reach the 800 to 1200 milligram hour group when the results are but little short of perfection. However final judgment must be withheld until the results are measured in terms of severe menopausal reaction. Although the incidence of 31 per cent with the minimal dosage is significant we have reason to believe that the figures obtained by our analysis of the two larger groups are more dependable. Here we find that the dosage usually employed meets expectations in the control of bleeding but that severe menopausal symptoms will be the price for such relief in 38 per cent of the patients. With reduction of the dosage to between 600 and 700 milligram hours, the incidence of these distressing symptoms is reduced one-half yet the bleeding is controlled satisfactorily in but 10 per cent less than with the larger dosage.

Twenty seven patients were between 50 and 60 and in this group the results come nearest to the ideal. The low incidence of severe menopausal symptoms as compared with that of the preceding decade is a striking feature of this age.

COMPLICATIONS

Of the 391 patients treated 1 died from Vincent's angina 7 days after irradiation. Two others developed a pelvic cellulitis with abscess formation in 1 and both recovered. The only other complication noted was femoral phlebitis in 1 patient. This low incidence of mortality and morbidity is a strong argument in favor of radium therapy. As to remote developments, a rectal ulcer was ascribed to irradiation in 1 and a second patient 21 years

TABLE VII—ANALYSIS OF THE 20-30 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mills hrs.	Bleeding controlled, per cent	Permanent amenorrhoea, per cent	Severe menopausal symptoms, per cent
100	61	0	4
1500	85	0	0

of age developed carcinoma of the fundus $3\frac{1}{2}$ years after the primary irradiation at which time the curettings showed hyperplasia

DEDUCTIONS FROM OUR STUDY

The ultimate purpose of a study such as this is to obtain data upon which comparison with other forms of treatment can be made and we shall apply the results of this analysis to that end. A discussion of medical and hormonal therapy in functional bleeding is not within the province of this paper. We have previously referred to curettage and roentgen therapy thus leaving for comparison hysterectomy with conservation of the ovaries and radium therapy.

Although uterine bleeding is the only symptom presented for relief its control is by no means the sole standard by which to gauge the efficiency of a given method of treatment. Were it so either hysterectomy or irradiation could accomplish the purpose equally well. Disturbance in function must be taken into consideration indeed this is in large measure the determining factor in judging the efficiency of either method of treatment.

With this conception constantly in mind we have reviewed our results in radium therapy. We have reported a morbidity of 0.76 per cent and 1 death for which the method could not be held responsible. Hysterectomy has not been performed by us in a sufficient number of patients with functional bleeding to permit of comparison but we know our results from hysterectomy with ovarian conservation in uncomplicated myoma in which the nature of the operation and the condition of the ovaries are identical. Hysterectomy will give a morbidity of approximately 10 per cent and a mortality of 0.5 per cent. Even with ovarian conservation severe menopausal symptoms will occur in about 7 per cent, when

TABLE VIII—ANALYSIS OF THE 30-40 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mills hrs.	Bleeding controlled, per cent	Permanent amenorrhoea, per cent	Severe menopausal symptoms, per cent
2-100	80	0	0
4-100	87	1	7
6-700	90		24
8-700	91	10	47

the uterus has been amputated sufficiently high to permit of menstruation the menopausal symptoms are largely eliminated. With hysterectomy the reproductive function is lost and the onset of the menopause will be earlier than normal.

Since the occurrence of severe menopausal symptoms will be stressed in this comparison a word concerning them is in order. Because of their frequency and severity they constitute the most formidable objection to irradiation. For some reason we are unable to explain the symptoms are more intense and more persistent in the irradiation menopause than in the surgical.

With these facts in mind the relative value of radium therapy and hysterectomy will be considered during each decade.

With radium therapy in women up to 30 years of age menstruation was restored to normal or nearly normal in 88 per cent, permanent amenorrhoea developed in 6 per cent and severe menopausal symptoms in 8 per cent. One patient developed phlebitis and 1 died from Vincent's angina. Of the 40 married women in this group 5 gave birth to normal babies and 8 had miscarriages subsequent to their irradiation. The evidence in favor of radium therapy at this age is so apparent as to make further discussion unnecessary.

Between 30 and 40 the picture changes. Although the bleeding was controlled in 95 per cent, permanent amenorrhoea developed in 24 per cent and severe menopausal symptoms in 21 per cent, this occurred at an age when preservation of ovarian function is of vital importance. Our analysis shows that increased susceptibility to irradiation begins after 30 and gradually increases, reaching its

TABLE IX.—ANALYSIS OF THE 40-50 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgh. hrs.	Bleeding controlled, per cent	Permanent amenorrhea, per cent	Severe menopausal symptoms, per cent
0-200	86	87	3
0-300	87	82	19
0-400	97	82	38

height in patients who continue to menstruate after 50. Further that the incidence of permanent amenorrhea and severe menopausal symptoms is parallel until 40 when, as amenorrhea increases, severe menopausal symptoms decrease. These facts are of importance in this age group because of their bearing upon the selection of dosage in case re-radiation becomes necessary. We have found that with an initial dosage of between 200 and 300 milligram hours the bleeding is controlled in 80 per cent with no permanent amenorrhea and no severe menopausal symptoms. With gradual increase in dosage there is a rapid increase in the menopausal reactions until with 800 to 1200 milligram hours, permanent amenorrhea occurred in 56 per cent and severe menopausal symptoms in 47 per cent.

In fairness to radium therapy let us analyze the initial dosage in this group. We find that the average dosage was much larger than it should have been and the conclusion is warranted that these unsatisfactory results are due not so much to the fault of the method as to its application.

In this group 70 married women gave birth to 6 normal babies and 4 miscarried. Two patients developed a pelvic cellulitis going on to suppuration and there were no deaths.

We believe that with a reduction of the initial dosage to 300 milligram hours and an increase of not more than 100 milligram hours, in case re-radiation becomes necessary radium therapy is the method of choice in this group. Should this fail we favor operation with preservation of ovarian function rather than increased irradiation.

Functional bleeding occurs most frequently between 40 and 50 years of age and because these women are approaching the time when,

TABLE X.—ANALYSIS OF THE 50-60 YEAR GROUP BASED UPON INITIAL DOSAGE AND RESULTS

Dosage mgh. hrs.	Bleeding controlled, per cent	Permanent amenorrhea, per cent	Severe menopausal symptoms, per cent
0-200	100	77	
0-300	90	90	6

in the normal course of events, functional activity will cease the administration of a menopausal dosage of radium has come into common usage. Our results show that with such an initial dosage, bleeding will be controlled in 97 per cent but with a severe menopausal reaction of 38 per cent. Reduction of the dosage to from 600 to 700 milligram hours will control the bleeding in 87 per cent and bring the incidence of menopausal symptoms down to 19 per cent. A 400 to 500 milligram hour dosage gives practically identical results so far as control of bleeding and permanent amenorrhea are concerned. As previously stated, its increased incidence of severe menopausal symptoms can be discounted in favor of that shown in the higher dosage group.

We do not know the incidence of severe menopausal symptoms under normal conditions but it probably lies between 5 and 10 per cent with an 800 to 1200 milligram hour dosage the bleeding will be controlled in 97 per cent but as the direct result of this treatment, the nervous stability will be seriously impaired in one-fourth of these women who would otherwise have escaped it. With a dosage of from 600 to 700 milligram hours, the incidence of severe menopausal reactions is reduced to 19 per cent but this, too, is high. Our experience with a maximum dosage of 400 milligram hours is not sufficient to warrant conclusions, but the evidence indicates that it would still further lessen the incidence of these reactions and at the same time control the bleeding in over 80 per cent.

So impressed are we by the results of this study that we propose to give the 400 milligram hour dosage a trial in women near 40 years of age. Should this and a re-radiation dosage of 500 milligram hours fail we believe operation should be considered because in the end, it is a more conservative measure than

increased irradiation. In women near 50, increased radium dosage or roentgen therapy can be used because the incidence of severe menopausal symptoms will more nearly approximate that of the uninduced menopause.

Between 50 and 60 years of age the results of radium therapy approach perfection. Maximum dosage can be given almost with impunity since severe menopausal reactions develop in but 3 per cent.

Based upon this study, certain general conclusions seem warranted. The value of radium therapy must be measured not only in terms of bleeding control but also of the menopausal

reactions which are produced by it. The deductions afforded by this study regarding these factors during the different decades and from graduated radium dosage, might be modified to some extent by a similar study of larger groups but sufficient evidence is offered to prove the value of small initial dosage up to 50 years of age and the dangers of large dosage. When other measures have failed to control functional bleeding, radium therapy is the best method at our command, but it has its limitations and should not be used to the exclusion of operation when these limitations have been reached.

MEDICINE AND SURGERY IN INDUSTRY¹

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IT is axiomatic that the value of the individual to society depends largely upon his health freedom from disabilities and his feeling of security in the knowledge that death is postponable.

When attempting to elucidate this complex and involved subject of medicine and surgery in industry one is confronted with his narrow limitations. We have sufficient knowledge to clarify this situation theoretically but have we the necessary practical wisdom to utilize this knowledge intelligently in bringing about a solution of some of the vital problems?

Several years ago Dr. Franklin H. Martin, director general of the American College of Surgeons, observed that the subject is a most important one and someone must do something about it. With his characteristic vision, his courage and his prompt action he established a Board the function of which was to make an accurate comprehensive and complete study of the entire subject of industrial medicine and traumatic surgery that the knowledge so gained might aid us in wise and judicial decisions for the betterment of all the involved interests. During the past year he has sent two excellently trained men into the field for the purpose of making a first hand fact finding study of the activities of industrial clinics in all their medical surgical and economic aspects. Some of the data thus secured might have been ascertained from information and statistics previously compiled and yet, as a basis for the formulation of a definite proposed plan and program there is no knowledge so valuable as that obtained by a first hand survey.

Upon the data thus secured it is proposed to approve such medical set ups in industry as shall conform to the minimum standard for such departments as it has been established by the College.

As a preamble in the consideration of the problems involved in industrial medicine three essential basic principles present themselves.

First the health, happiness, efficiency and general mental and physical welfare of the employee. This is the paramount object.

Second the protection of the rights and the ethical standards of the physicians in their relation to the worker in industry. All of these principles must be safeguarded.

Third the direct and indirect economic saving that will accrue to the employer the employee and to society at large if intelligent scientific surgical and medical care is given to the employees and their families.

Is there any conflict of interest in a joint consideration of these principles? In this rapidly changing era of our present day civilization has the time arrived when these stated principles must be intelligently considered and plans perfected for their more effective application? There is no paradox in such a consideration and the community of interests demands that thought be devoted to it.

During the past few years a vast amount of literature has appeared in the medical and lay press relative to the alleged high cost of medical care and hospitalization. Extensive surveys have been made and comprehensive data secured and tabulated on this subject. There appears to be a popular psychology and a generally accepted opinion that these costs are too high. Will a careful and accurate analysis of this whole situation confirm this opinion? We believe it will not and that it is a debatable question.

Apparently what has happened is that the present extent and cost of the means and the methods employed in arriving at an accurate scientific diagnosis and the applying of the proper therapeutic measures to the sick and injured patient have evolved and increased beyond the ability of the average patient with an average income to pay this medical expense as an individual. Will it be possible to formulate and to put into execution some plan or program whereby this ever increasing cost can be met by society in some collective arrangement? Is this the crux of the problem?

No one will agree with the thought that the scientific methods now employed should be abandoned or curtailed, or that all of the people in all walks of life should not enjoy the benefits of the best in medicine and surgery. All the sick are not receiving adequate care under present conditions. Our present system of caring for the sick and injured leaves much to be desired. The value of health welfare of workers in industry in a community in a municipality in a state in a nation, transcends any other consideration.

Complete examinations of the men made during the drafts for the army in the late war revealed that large numbers approximately one third were wholly unfit for duty. Similar examinations made of the men now engaged in the army of industry would show a greater proportion of unfit and handicapped.

Are proper remedial measures being taken by industry to correct this unfortunate condition? No! How simple the logic and the deduction that no organization can be stronger and more efficient than the individuals that compose it. The measure of the constructive work that has been done for the health of employees in industry during the past few decades is the condition of their health at the present time as compared to the past. There may have been some improvement but certainly that improvement is infinitesimal. Organized medicine has an unalterable duty in exerting every effort to evolve a far seeing plan to remedy existing conditions and to employ every known method in an attempt to improve the health welfare of employees in industry.

What of this whole situation as it relates to the material self interests of the physician about which there is so much discussion at the present time?

During the past few decades industrialists have made an effort to establish medical departments in their industries and as a result of this activity there came into existence the name 'industrial surgeon,' to designate the physician who assumes the administration of these departments. Unfortunately, in the earlier years some criticism arose of the ethical methods of these men because they were considered contract surgeons and it was reasoned

that they employed unfair methods in competition with their fellow practitioners. Fortunately some of this has passed and it is now recognized that many of these industrial surgeons had broad far reaching vision and that they were worthy pioneers in the advancement and promotion of better medicine and surgery as it pertains to the worker in industry.

It is within the scope of discretion to venture the opinion that the fellows of the American College of Surgeons have been ignorant of the potentialities in industrial medicine and surgery. Bias and prejudice have played a large part in this indifference. This attitude is changing and a keen interest is developing rapidly in all phases of industrial medicine. Obviously there can be no advancement made in medicine unless the material interests of the profession are protected and conserved and this must not be forgotten in any thought of medicine and surgery in industry.

Can not some plan be promoted whereby all the physicians in any industrial community may profit by and partake in any and all of the activities in medicine and surgery that in industrialists may be stimulated and inspired to initiate? We believe it can and one concrete suggestion occurs to us. Given a community in which there may be several small or one large industry, it should be possible and feasible to induce the executives of industry to subsidize and partly support a semi public diagnostic clinic to which all of the physicians of this locality should have access and where all patients might receive the advantages of trained technicians and complete laboratory examinations. This at a cost within the reach of all. Naturally this would result in an advantage to the patient the physician, and incidentally the industrialists would profit financially to an extent that is difficult to estimate or overstate.

Think of the vast if intangible, financial gain that would accrue to industry if any given industrial community could be made healthier and the health welfare and happiness of that area conserved and protected. Again it is not possible to estimate accurately the increased working power of the men under such a condition.

This is but one of the many arrangements that could be put into effect adding to the profit of the physician in financial gain and educational advancement.

Is it not the unquestioned duty and privilege of the fellows of the American College of Surgeons to become vitally interested in this subject of medicine and surgery in industry and to pursue a study of the entire situation so that a solution of some of the problems may be arrived at through the combined opinion, judgment, and effort of the carefully selected men composing this great organization. The measure of the success of any of the proposed solutions of the mooted questions in the situation of medicine and surgery in industry can be expressed in terms of the advantages that will accrue to the worker the physician and to industry.

How will leaders of industry benefit and how can we as physicians secure the largest measure of co-operation from these leaders in any proposed plan for better medical and surgical care for the employee?

No appeal should be made to these executives on the basis of philanthropy nor should there be an appeal to capitalistic greed but the appeal should be made on sound financial judgment and business sense which will demonstrate an advantage and profit to all branches of society. In the past there has been a tendency in industry to devote a disproportionate amount of thought and capital to the care of the injured rather than to the sick or handicapped worker. The magnificent work of the National Safety Council has resulted in such an enormous decrease in industrial accidents that there is an ever declining necessity for surgery in industry. How much larger and more important is the field of medicine as it applies to industrial relations.

Some of the larger industrial organizations have a most efficient and effective medical department and have achieved striking results from their activities. It is to be noted how ever that only a small percentage of all employees are engaged in organizations employing five hundred or more men. Data taken from the United States Bureau of Census report 1929 shows the following over 95,000

plants employed 1 to 5 persons each 194,266 plants employed 1 to 100 persons each. The total number of wage earners employed in these plants is 2,581,578 and it is safe to say that a vast number of employees in these smaller plants receive no medical supervision as a group or that the care provided is entirely inadequate.

A word about some of the practices now employed may be constructive. In many plants particularly the smaller ones, the medical department consists of a few dressings and drugs and possibly a separate room known as the first aid station. If such an arrangement is under the control of a competent surgeon, it may serve a useful purpose but all too often it is presided over by an untrained, unskilled fellow employee, not even a trained nurse being employed. The statement that such a plan is a vicious practice cannot be controverted. Under such conditions attempts are frequently made by these unskilled people to remove foreign bodies from the eye which are imbedded in the cornea, or another common procedure is the unsuccessful effort to remove a splinter of wood from beneath a finger nail. Corneal ulcers and infected fingers are the result, with the subsequent loss of an eye, a finger or a hand. Trained nurses in charge of these so called dressing stations who are not controlled by a competent medical adviser are of questionable value.

One of the worst influences that has grown up in the medical departments of industry and in the contacts with insurance companies in workmen's compensation cases is the interference by the personnel man at the plant and the claim agent in insurance. These men all too frequently dominate the situation and control any and all medical activities. Their motive is prompted by the narrow minded desire for immediate financial gain.

This condition of affairs must be combated and changed if advancement is to be accomplished. Until the late war a similar condition existed in fighting armies. The general staff officers were in supreme control of the welfare and disposition of the soldiers. The medical officer was relegated to the subordinate position of caring for the sick and

wounded, controlled of course by the general staff officer. The medical officer had no voice in the location of a camp or base area and often his comments or advice as to water and food supply went unheeded. The staff officer was interested as he thought only in the man at the front fit for duty. The sick and wounded were not his vital concern.

Think back to the time of the occurrence of typhoid fever dysentery tetanus and the scandal regarding the food supply that existed during the Spanish American War. The Civil War, Boer War and previous wars all had similar difficulties. All this was changed during the World War. It was recognized early in the conflict that victory would depend upon man power as measured in terms of numbers morale and health welfare. The wise leaders and administrators immediately conceived the plan of securing the best and most scientific medical and surgical talent that was available and of giving these men sufficient authority to direct and control the health welfare of the troops. The medical profession came into its own.

What was the result? No typhoid no dysentery, no tetanus and the morale of whole armies raised by the knowledge that if injured they would receive the most prompt skillful scientific surgical care possible.

You are all familiar with the excellent medical organization in our own army. The untiring efforts and administrative and executive ability of General Gorgas and Dr. Franklin H. Martin, our own director general were responsible for the securing of the loyal support of all branches of the country's medical activities. The Secretary of War Newton D. Baker had a sympathetic understanding of the requirements and gave his unqualified approval to the recommendations of these men. This is a matter of historic record. The benefits derived from such an organization, in the preservation of the health of the men in the army and in the skillful care given to them when wounded, cannot be overestimated.

Can the circumstances and conditions involved in considering the effectiveness of an army of soldiers equipped for war be compared to those of the peace time army of industry?

Are the great captains of industry assuming the same attitude toward the medical profession that was formerly assumed by the general staff officers toward the army medical corps?

If these questions can be answered in the affirmative and we believe they can then it is our unqualified duty to elicit the support of every medical man in conceiving and executing a remedial plan. Great industrialists are intelligent leaders who are amenable to logic and reason. It should not be difficult with the accurate and extensive statistics that are now available to convince these men of the financial advantages and profit that will accrue to their stockholders if the health welfare of their employees can be conserved and improved.

It is conservatively estimated that 360 000 000 working days are lost to industry through disabilities due to sickness or at a rate of \$3.00 per day over \$1 000 000 000 (one billion dollars) are lost yearly from illness.

Nearly all large industries are at the present time spending vast sums of money in what is known as their research departments and yet the results from the expenditures of these millions are frequently not immediately evident or tangible. Should it be difficult to convince the executives of industry of the large financial advantages of maintaining a research medical and surgical department to study methods and means for improving the health of their employees? It is our conception that a united effort on the part of the medical profession in collecting data on this subject would result in securing the most convincing evidence with which to demonstrate that the establishment of a health research department in all large industries would result in an enormous economic saving to the employer. The employee and society at large would most certainly profit. Consider one concrete condition, the so called ordinary cold. Try to imagine how much economic waste occurs from this prevalent inflection resulting in labor turnover and in rearrangement and shifting that must occur within any given department when employees are absent or at work and not functioning efficiently. How many times this concrete example could be repeated by citing other health conditions

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It is recognized that only the social and economic aspects of medicine and surgery in industry have been presented. The assumption is that the fellows of the American College of Surgeons are well versed in the professional phase of this all important situation.

Leaders in any human accomplishment are men of character men with ambition men with vision men with courage and men endowed with the untiring energy and persistent application to the work necessary in their efforts to achieve their desired end. Such leaders constitute the selected membership in this organization. You fellows of the American College of Surgeons are leaders of influence in your respective communities. We appeal to you to go back home and exercise that leadership. Become representatives of the College in your daily contacts with industrialists large and small and sell to them a far seeing program for the standardization and rationalization of better medicine and surgery in industry.

Such a program proposes and comprises the following

1 The education of the industrialists so that they will come to recognize the financial saving and gain that will be shown by increased profits and dividends if their human machinery can be made to function more efficiently because of better health and strength.

2 To carry the thought to organized medicine that their self interests, both immediate and remote will be conserved and enhanced with the establishment of proper medical and surgical departments in industry controlled and regulated by the leaders in the medical profession so that their financial remuneration and ethical standards shall be maintained.

3 The employee, whose welfare is the paramount issue needs no further education or convincing for he understands that he will be the beneficiary. Organized labor is already committed to such a plan. The American College of Surgeons pledges itself to the promotion of such a plan.

May we say to each and every one of you that this is your opportunity and the responsibility for the success of such an undertaking is yours.

FRACTURES AND DISLOCATIONS IN THE REGION OF THE ELBOW

PHILIP D. WILSON, M.D., F.A.C.S. Boston
 From the Fracture Service, Massachusetts General Hospital

FRACTURES and dislocations in the region of the elbow are extremely common and on account of the toll of deformities and disabilities they have levied in the past have won a reputation for formidableness that is scarcely equalled. Although much has been written about these injuries there still remain sufficient gaps in our knowledge to justify further study of them. It will be our purpose in this article to present a more or less comprehensive view of all the different lesions that are designated by the title "Fractures and Dislocations of the Elbow." Many of the injuries are multiple and it is only by including all in the study that an accurate picture can be presented of the whole.

For the purpose of gathering material we have reviewed the records of 352 patients with 439 fractures or dislocations of the elbow that have been treated by the staff of the fracture service of the Massachusetts General Hospital between the years 1924 and 1930 inclusively. Of these 174 patients with 213 injuries about the elbow were treated as in patients and have been carefully studied and followed. End result clinical and X-ray examinations have been made at a period longer than 1 year after discharge from the hospital in 140 patients with 176 elbow injuries representing 82 per cent of all the house cases. The other patients were treated in the emergency ward and out patient department of the hospital. For the most part their injuries were of less severe type so that hospital admission was not considered necessary. The records of these patients are incomplete and contain notes only of the diagnosis and treatment at the time of the first visit. These have been used chiefly for statistical purposes in order to give as complete a picture as possible of the entire problem. During the 7 year period covered by the study the total number of patients with fractures and dislocations treated in all departments of the hospital was 4,066 and the total number of skeletal injuries was 4,536 so that the fractures and dislocations of the elbow

represented approximately 10 per cent of the entire group.

A word of explanation is necessary in respect to the system of grading end results that is employed at the Massachusetts General Hospital. The result is evaluated from three standpoints: A (anatomic), F (functional) and E (economic) and is expressed by numbers ranging from 0 to 4, the former representing the minimum and the latter the maximum. Considerable latitude is permitted by the numbers: 1 representing from 0 to 25 per cent, 2 from 25 to 50 per cent, 3 from 50 to 75 per cent, and 4 from 75 to 100 per cent. "Anatomic" refers to bony alignment and is determined from the X-ray; "functional" takes into consideration the range of joint motion, muscular strength and the presence or absence of pain; while "economic" refers to working and earning ability. For example, A₂ F₄ L₄ means that the X-ray shows slight bony deformity but that functionally the patient is practically normal and that he is able to do the same work and earn the same wage as before injury. A₁ F₂ E₂ indicates less than 25 per cent of normal alignment, less than half of the normal motion and only about 75 per cent of the previous earning power.

Types of injury. It is important to make an accurate diagnosis of the exact type of fracture or dislocation of the elbow as the methods of treatment are different, and each carries its own particular dangers. Many of the unsatisfactory results that are seen after injuries of the elbow are the result of failure to distinguish between the different types and the attempt to treat all without distinction by one common method.

Epiphyses. The lower end of the humerus lacks a single common epiphysis similar to that at its upper end or to those at the ends of the radius, femur, and tibia. Instead, ossification proceeds from several distinct epiphyseal centers which unite with the shaft at different age periods. Any of these epiphyses, such as the capitellum or medial epicondyle,

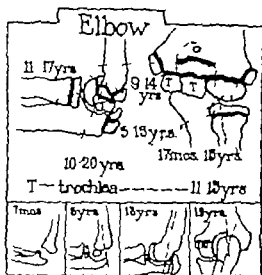


Fig. 1. Diagram showing ossification of the epiphyses of the elbow. (From Camp and Cilley. *Am. J. Roentgenol.* 43: 227, Dec. 1.)

may become separated as a result of trauma during the period when it is vulnerable but epiphyseal fracture of the entire lower end of the humerus almost never occurs, and no single instance of it was found in our series. A

TABLE I—GRAND SUMMARY SHEET

	House cases			Emergency ward		
	Num-ber	Per-cent	Ex-cludes	Cases	Total	Per-cent
Supracondylar	57	80.7	26	23	8	76
Medial epiphysis	4	58.5		13	36	66
External condyle	6	92.6	5	1	66	94.6
Lateral condyle	5	92.3	3		6	92.6
Intercondylar		92.6	1.3		6	92.3
Capitulum epiphysis		96	3			96.3
Lateral epicondyle				7	7	97.6
Fracture of capitulum	3	94.4	3		3	94.7
Total lower end humerus	106	90.4	90	23	86	43.3
Head and neck radius	20	14.7	24	4.5	7.5	7
Olecranon	1.3	1.5	2.5	2.6	6.6	1.4
Coronoid	7	92.3	6	8	13	92.6
Upper end elbow joint	3	92.4	2		3	92.7
Total fractures	186	85	146	143	143	78
Acromioclavicular joint head	3	94.4	3		3	94.7
Dislocations	30	4	3	6.3	6.3	11
Total injuries	213	100	150	150	206	100

knowledge of the normal X-ray appearance of the epiphyses and of the age at which they unite is essential for the proper treatment of fractures (Fig. 1).

Frequency of the various injuries. The relative frequency of the different types of fractures and dislocations about the elbow is shown in Table I. The most common injuries in order of frequency were first, dislocations second supracondylar fractures third, fractures of the head and neck of the radius fourth fractures of the olecranon process.

Multiple injuries. Many of the skeletal injuries about the elbow are multiple. This is particularly true of the dislocations which are frequently accompanied by fractures and of the fractures of the olecranon, upper extremity of the radius coronoid process, and medial epicondyle, which are often associated with other injuries either fractures or dislocations. The incidence of the complicating injuries in respect to the various fractures and dislocations of the elbow is shown in Table II.

Nerve injuries. Injury of one of the main nerves of the arm complicated the fracture or dislocation in 9, or 5 per cent of the 174 house patients. All of these injuries were of the nature either of contusions or stretching of the nerve and spontaneous recovery occurred in every instance. The various lesions are shown in Table III.

Age distribution. It may be seen from the graph (Fig. 2) that fractures and dislocations of the elbow occur with the greatest frequency among children actually 101 or 58 per cent, of the house patients were under 15 years of age. This fact should prove a stimulus to the surgeon because childhood is the most favorable age for recovery from skeletal injuries, and on that account failure to avoid functional impairment seems doubly tragic.

I. SUPRACONDYLAR FRACTURES OF THE HUMERUS

The supracondylar fractures were numerically the most frequent of the injuries in the region of the elbow and constituted 19 per cent of our group of cases. The incidence was highest in childhood, and 92 per cent of the patients were under 15 years of age, and 84 per cent below the age of 10. There seemed to

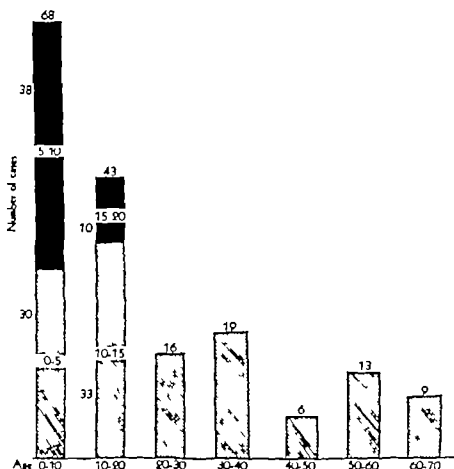


Fig. 2 All injuries of the elbow (174 house patients) Age distribution by decades.

be an extraordinary resistance to this injury in adult life judging by the absence of any instance of it between the ages of 20 and 50 years. It was re-encountered in the elderly group, and 4 of our patients were in the sixth decade (Fig. 3).

The fracture is more accurately described as diacondylar than supracondylar, but since the latter term is better known, it will be retained. The fracture line passes transversely

through the upper part of the condyles instead of above them, and in the lateral plane it slopes obliquely downward and forward. It is usually produced by a fall on the outstretched hand with backward and upward thrust on the forearm. The lower fragment is displaced backward, and the lower end of the upper fragment

TABLE II.—COMPLICATING INJURIES OF ELBOW FRACTURES

	Cases	Multiple injuries of elbow elsewhere	Fracture elsewhere
		Cases	Per cent
Supracondylar	82	2	2.4
Medial epicondyle	36	15	42
Lateral epicondyle	7	2	28
Condylar fracture	50	4	8
Dislocation of elbow	93	56	60
Head and neck of radius	72	17	23
Olecranon	67	15	24
Coronoid (E.W.)	15	12	80
Capitellar epiphysis	11	1	9
Capitellum	3	2	66

TABLE III.—NERVE INJURIES

Nerve	Primary lesions	Secondary lesions	Total
Radial	2	2	4
Ulnar	5	0	5
Median	0	0	0
			9
<i>Radial nerve</i>			
Intercondylar fracture of humerus			1
Supracondylar fracture of humerus (1 post reduction)			2
Fracture head and neck of radius (post operative)			1
<i>Ulnar nerve</i>			
<i>Dislocations of elbow with fracture of medial epicondyle</i>			
Comminuted fracture of olecranon and upper ulna			4
			1

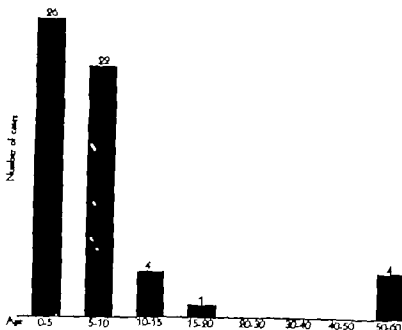


Fig. 3. Supracondylar fractures (57 house patients) Age distribution by decades.

comes to lie anteriorly and medially in close relation to the brachial vessels. Occasionally it escapes through the skin producing an open or compound fracture. In the group of patients (57) studied there were two with compound fractures or an incidence of $3\frac{1}{2}$ per cent.

The flexion type of supracondylar fracture, although rare (3 examples in 57 cases or 5 per cent) needs to be distinguished from the common hyperextension type of fracture. It generally results from a fall on the flexed elbow and the deformity is reversed the lower fragment being displaced forward instead of backward. Closed reduction is brought about by extension of the elbow instead of by flexion and if correction is obtained splints should be applied with the elbow in this position. The deformity is generally increased by the position of acute flexion. In the group of patients studied there were 3 examples of this type of fracture. Two were adults and one a child. Open reduction was necessary in the two former and closed reduction was satisfactory in the latter.

In the common type of supracondylar fracture when the patient is seen within a few hours of the injury reduction can generally be

accomplished by the manipulative method and the correction maintained by the position of acute flexion of the elbow. It needs to be emphasized that the position of acute flexion is not a means of reducing the fracture but of retaining alignment after reduction has been accomplished. Reduction may be performed as follows with the patient anesthetized and an assistant making countertraction on the upper arm, traction should be exerted on the forearm the elbow being extended. The elbow should be drawn downward and rotary displacement corrected. The lower fragment should then be pushed forward and the elbow slowly flexed. If the reduction is performed within a few hours of the injury before there is any vascular interference from swelling and if the replacement is complete it will be possible to bring the elbow into a position of complete hyperflexion without obstructing the radial pulse, and it should then be fixed in that position either by the application of a snug bandage or by a molded posterior plaster splint. Retention by a circular strip of adhesive plaster in our opinion is dangerous and likely to interfere with the circulation.

Ischemia The great menace of the supracondylar fractures is much more from vascular

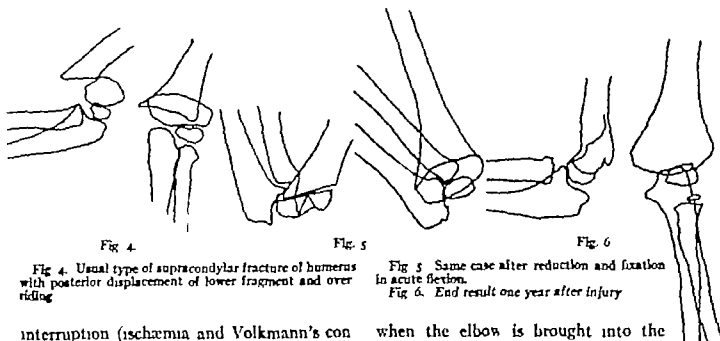


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 4. Usual type of supracondylar fracture of humerus with posterior displacement of lower fragment and overriding.

Fig. 5. Same case after reduction and fixation in acute flexion.

Fig. 6. End result one year after injury.

interruption (ischæmia and Volkmann's contraction) than from functional impairment due to faulty reduction of the fracture. Ischæmia that dreadful complication often equivalent to total loss of the arm is ever imminent and this danger must always be kept in mind. While in most instances it is a consequence of the injury rather than of the treatment and may develop in the complete absence of all constrictive dressings there is little doubt that failure to recognize it when impending and therefore to take all needful steps to prevent or check it may make a great deal of difference in respect to the amount of function that may be saved. Examination should never be confined to the region of the fracture but should include the entire extremity and tests of the circulation: cutaneous sensibility and motor power of the hand and wrist should always be made.

Absence of the radial pulse, pallor and coldness of the hand, inability to flex or extend the fingers and loss of cutaneous sensibility are the signs of fully developed ischæmia and in our opinion demand immediate operative intervention as will be described later. But it is equally necessary to recognize the signs of incomplete circulatory disturbance, and in that case to adopt a plan of treatment that will take into account both the needs of the fracture and those of the circulation as well. By these signs I refer to the presence of marked swelling about the elbow, cyanosis of the forearm and, above all, to interruption of the radial pulse

when the elbow is brought into the position of acute flexion. The radial pulse must be the guide post not only during the reduction of the fracture but also throughout the immediate after treatment and must always be carefully watched. Disappearance of the radial pulse while the elbow is being flexed following the reduction of the fracture is a sign either of incomplete reduction or of such great extravasation into the soft parts and infiltration of the tissues that the brachial artery becomes compressed as a result of the postural tension. In either case it is an indication for the return of the elbow to a position in which the radial pulsation can again be felt, and for the application of splints in that position to maintain the best alignment possible. When the circulatory balance is particularly bad it may be the part of wisdom to abandon all attempts at reduction for the moment, and instead to concentrate on improving the circulation by such measures as elevation, application of radiant heat, and even operative intervention, if indicated. After a few days when the swelling has subsided a second attempt at closed reduction may be made, or open reduction may be performed. An alternative method that has given successful results is the application of skeletal traction from an overhead frame by means of a Kirschner's wire inserted in the olecranon process. This obtains reduction of the fracture, permits the elbow to assume the position of flexion from the unsupported weight of the forearm, and

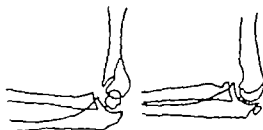


Fig 7 A. Roentgenologic appearance of malunited supracondylar fracture of humerus three months after injury. Note that ulna has taken place with the lower fragment lying posteriorly and that the lower end of the proximal fragment projects anteriorly and appears to block flexion. B. Same elbow three years later showing correction of deformity by process of growth.

at the same time secures elevation and relieves swelling.

Frank established ischemia requires immediate operative intervention. Let no one depend upon closed reduction of the fracture as a means of relieving pressure upon the vessels. Our own tragic experience with 2 patients shows the futility of this method (see Table IV). On the other hand, gratifying results were obtained in 2 patients by incision along the inner side of the elbow, evacuation of the hematoma, and by exposure and freeing of the vessels. In one case the latter were found twisted about the upper fragment and the pulsation immediately returned upon freeing them. This experience was particularly

encouraging and holds out hope that by immediate operation in the early stage Volkmann's ischemic contraction can be prevented either completely or partially. Ischemia developed in 3 of our 82 patients, or 6 per cent. Data concerning these patients is shown in Table IV.

Vascular disturbance of greater or lesser degree was present in a large proportion of the patients studied and in these the treatment of the fracture was made secondary to safeguarding the circulation. In 23 of our 57 house patients more than one closed reduction was performed. This was usually due to the fact that the radial pulse was shut off by the position of acute flexion of the elbow and that correction could not be maintained with the elbow in a less favorable position. Open reduction was performed in 11 cases. Five of these operations were necessitated by failure of closed reduction. 1 was in a compound fracture where open reduction was combined with immediate débridement, and the 3 remaining were in patients who were admitted late, that is from 4 to 10 days after injury.

The treatment after either closed or open reduction consisted of immobilization for a period of about 3 weeks followed by protection in a sling for 1 or 2 weeks longer. No effort was made to employ early massage and movement. End result examinations were made in

TABLE IV—SUPRACONDYLAR FRACTURES WITH ISCHÆMIA—FIVE CASES OR SIX PER CENT OF EIGHTY TWO CASES

Identification	Age	Time after injury	Examination of hand	Treatment	Result
C.H. (a 55412)	4	3 hrs. No previous treatment	Pallor and loss of sensation and power. Absent pulse	Immediate closed reduction. Right angle flexion; elevation; heat.	Volkmann's contraction. At Pt. Ex.
R.H. (W. 569327)	8	hrs. No previous treatment	Pallor. Loss of sensation and power. Absent pulse	Immediate closed reduction. Right angle flexion; elevation; heat.	Volkmann's contraction. At Pt. Ex.
W.H. (W. 569596)	5	6 days. Radial pulse par. formed elsewhere and elbow fixed in flexion	Hand swollen, cyanotic and tender. Loss of sensation and power. Absent pulse. Elbow swollen. Forearm sore	Split removed, elbow extended. Elevation, heat. Closed reduction 10 days after injury. Right angle flexion	Volkmann's contraction. X-ray 3 days after injury. End result favorable
C.R. (W. 569328)	3	4 hrs. Two attempts at reduction made elsewhere	Hand swollen, cyanotic and tender. Unimpaired sensation. Loss of sensation of lower arm. Forearm radial pulse. Elbow swollen	Split removed. Elbow extended and elevated. At end of 5 days closed reduction. Pulse disappeared. Swelling increased over area of venous thrombosis. No reduction. 100° extension	Slight flexion contraction of wrist. Covered up with physical therapy. At Pt. Ex.
M.T. (E. 576179)	5	hrs. No previous treatment	Hand pale. Loss of sensation and motor power. Absent radial pulse	Immediate operation. Medial incision; lower half of bone exposed. Exposure and freeing of vessels found twisted about upper fragment. Flap with elbow extended. Later closed reduction unsuccessful	Pulse returned. No contraction. At Pt. Ex.

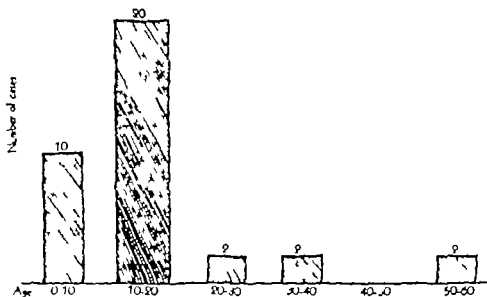


Fig. 8. Medial epicondyle fractures (36 cases) Age distribution by decades.

45 of the 57 patients more than 1 year after discharge from the hospital and the gradings are shown in Table V. The outstanding impression from their study is the excellence of the results. They were graded excellent or good meaning practically normal function in 37 or 82 per cent. There were 3 poor results, 2 due to ischaemia and 1 due to gas bacillus infection developing in a patient with a compound fracture who had been treated elsewhere and in whom disarticulation of the shoulder had to be performed immediately upon admission. Five results were graded as fair, meaning some alteration of alignment and moderate limitation of elbow function. Only 3 of these were attributed to our treatment, one being a case of ischaemia, another a patient admitted only after a delay of 10 days in whom an open reduction was done and the third the case of a patient with a compound fracture who re-fractured the elbow 7 months after the first injury.

It remains to be added that a considerable number of good and even excellent results were obtained even in the absence of complete reduction. Several patients with old malunion and uncorrected complete posterior displacement of the lower fragment have been followed in the fracture clinic and in the end obtained useful elbows. Bony consolidation always took place and although in the beginning there was an ugly deformity which seemed to block flexion of the elbow, even this

was eradicated in the course of time as growth from the lower epiphysis elongated the humerus and pushed the elbow away from proximity to the point of injury. This should be remembered when dealing with fractures associated with vascular disturbance. Change in the carrying angle of the elbow was noted in some of the end result examinations, but rarely exceeded 5 to 10 degrees, and seemed to be of little functional significance. It would seem that the alteration must be of a rather gross type if it is to constitute a handicap. The ability completely to extend the elbow was

TABLE V.—RESULTS IN SUPRACONDYLAR FRACTURES

	Total	Excellent As Fx Ea	Good As or F Ea	Fair As Fx Ea	Poor	Un- known
<i>Flexion type of fracture</i>						
Closed reduction	5		1			
Open reduction	4		1			1
<i>Hyperextension type of fracture</i>						
No displacement	1	1				
Old malunion (physical therapy)	3		1	1		
Closed reduction	23	23	4		1	0
Open reduction	9	3	3	2		1
Refused treatment	1			1		
Compound fractures	3			1	A, 1	
Totals	37	27	8	3	2	13

L.—Ischaemia; A.—Amputation.

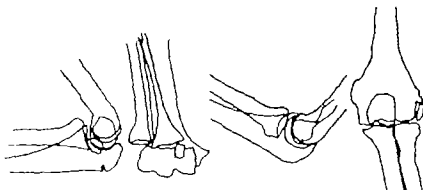


Fig. 9, left. Posterior dislocation of elbow with fracture of medial epicondyle following reduction. Note that the epicondylar fragment has been caught in the joint space. This patient had ulnar palsy.

Fig. 10. Same case as Fig. 9 showing end-result 13 months after injury. The epicondylar fragment was removed, and the patient has recovered from the ulnar nerve lesion. There is a small area of calcification in the lateral portion of the joint capsule.

recovered in almost all cases restriction of 10 to 15 degrees being found only in a few.

II FRACTURE OF EPICONDYLES

Fracture of the medial epicondyle is common while fracture of the lateral epicondyle is rare. There were 36 patients with the former injury, or 8.2 per cent of the entire group, while there were only 7 instances of the latter injury (1.7 per cent), all insignificant and none requiring admission to the house. The difference in the frequency of the two injuries is accounted for by the difference in ossification of the two processes, the medial epicondyle having a large separate center of ossification while there is only a tiny center of ossification for the lateral epicondyle, which is well protected and does not serve as an important point of attachment for muscles or ligaments. The epiphyseal center for the medial epicondyle appears at about the ninth year and unites from the fourteenth to the fifteenth year.

Most of the fractures affecting the medial epicondyle are in reality epiphyseal separations. This is shown by the age of the patients—of the 14 patients with this injury 13 occurred between the ages of 10 and 17 years (Fig. 8).

The medial epicondyle is most commonly fractured in association with posterolateral dislocation of the elbow, being pulled away by the attachment of the strong internal lateral

ligament. This association was found in 14 of the 36 examples of this injury, or 40 per cent. The injury may be complicated by other bony injuries due to the dislocation, such as fracture of the head or neck of the radius and of the coronoid process. In the cases of fracture uncomplicated by dislocation the injury is the result either of direct violence applied to the epicondyle or of an adduction strain of the elbow.

The treatment of fractures of the medial epicondyle is chiefly the treatment of the associated injuries, that is reduction of the dislocation if present followed by fixation of the elbow in the position of acute flexion. Nothing can be accomplished in the way of direct closed reduction of the fracture, but the position of acute flexion secures relaxation of the flexor muscles of the forearm which are attached to the epicondyle and thus tends to bring about replacement.

No functional impairment need be anticipated following fracture of the epicondyle unless there is an accompanying dislocation. When the two occur in association the prognosis is that of the dislocation. In our group of 14 house patients of which 11 had associated dislocations, end result examinations were made in 11. The functional results were excellent in 10, although in 3 the epicondyle had united by fibrous union only. One result was poor, but this was due to the dislocation and not to the fracture.

TABLE VI—DISLOCATION OF THE ELBOW WITH FRACTURE OF THE MEDIAL EPICONDYLE AND DISPLACEMENT INTO THE JOINT

Identification	Age	Length of time after injury	Reduction of dislocation	Ulnar palsy	Treatment	Result
W. I. I. (O 5977-1)	11	Few hours	Immediate closed reduction	Complete	Excision of fragment. Transplant of ulnar nerve	A, F, E
G. W. M. (W 110419)		1 days	Dislocation reduced by out side physician	Complete	Excision of fragment. Transplant of ulnar nerve	A, F, E
K. L. (O 48564)	16	Few hours	Immediate closed reduction	N	Immediate operation replacement of fragment	Immediate result good. Final result not known
D. A. T. (E 43119)	16	3 months	Dislocation reduced by out side physician. Mild impaired elbow function	Complete	Transplantation of ulnar nerve. Nothing done to fragment	A, F, E Recurrent nerve function but had limited flexion and extension of elbow
P. T. (O 454-16)	4	12 hours	Dislocation reduced by out side physician	Complete	Excision of fragment. Transplantation of ulnar nerve	A, F, E

IIA DISPLACEMENT OF THE MEDIAL EPICONDYLE INTO THE ELBOW JOINT WITH ULNAR PALSY

There is one complication that must always be looked for in patients with dislocation of the elbow and fracture of the medial epicondyle. This is displacement of the epicondylar fragment into the elbow joint and imprisonment of it there when the dislocation is reduced. The ulnar nerve being attached to the epicondyle is carried along with it into the joint and later becomes pinched between the articular surfaces when reduction of the dislocation is effected with resulting ulnar palsy. Usually the first warning of the presence of this complication is the appearance after reduction of the characteristic signs of ulnar nerve injury. An X-ray examination should be made however both before and after the reduction and in the first films the appearance of the epicondylar fragment lying widely displaced and slightly to the outer side of the medial ridge of the trochlea should lead one to anticipate its occurrence while in the postreduction films the inter-articular position of the fragment is clearly shown (Figs 9 and 10).

The treatment of the condition necessitates immediate operation to remove or replace the fragment and to free the nerve. The longer the nerve is compressed the greater the time that will be required for its recovery. Occasionally ulnar palsy is absent, but even then the intra-articular fragment should be removed as it will interfere with elbow function. In our opinion it is preferable to excise rather than to replace the fragment as this elimi-

nates the problem of fracture healing and the patient may be treated as for an uncomplicated dislocation alone. If the fragment is removed it is advisable to transplant the nerve to the front of the elbow for the sake of safety. Excision of the fragment causes no functional impairment.

In our group of 14 patients with fracture of the medial epicondyle associated with dislocation of the elbow the epicondylar fragment was caught in the joint after the reduction in 5 instances. In 4 of the 5 cases there was complete ulnar palsy. The treatment and results are shown in Table VI.

III FRACTURES OF THE CONDYLES OF THE HUMERUS

The group of the condylar fractures includes fractures of the medial and lateral condyles and the intercondylar or so-called T fractures. The fractures of the single condyles are usually oblique splits extending downward from the lateral or medial supracondylar ridge respectively into the trochlear or capitellar

TABLE VII—FRACTURE OF THE CONDYLES OF THE HUMERUS

	House cases	F. B. cases
Internal condyle	5	11
External condyle	1	14
Intercondylar	12	2
Total	18	27

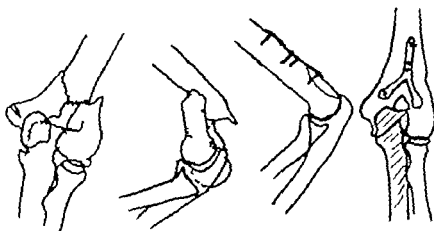


Fig. 1 Intercondylar fracture of lower end of humerus treated by open reduction and internal fixation. A and B. X-rays showing the deformity upon admission to the hospital. C and D. X-rays taken one year later showing end-result after open reduction.

TABLE VIII.—FRACTURES OF THE CONDYLES OF THE HUMERUS (INTRA-ARTICULAR)

Internal Condyle

Identification	Age	Period after injury	Complications	Displacement	Treatment	Result
H B (E 26140)	19	Few hours	None	++++	Closed reduction unsuccessful. Open operation performed with excision of condyle	As Pt Ea A poor result
H M (E 266117)		Few hours	None	++++	Closed reduction with fixation at right angle failed. Second closed reduction performed later with fixation of elbow in acute flexion	AxPtEa Right luxation of elbow
A P (O 27 874)	34	Few hours	None	++++	Closed reduction unsuccessful. Open reduction performed with fixation of fragment by steel screw	AxPtEa Right luxation of elbow
C H A (O 28)	52	Few hours	Recent operation for osteoarthritis	+++	Closed reduction performed with fixation of elbow in acute flexion. Malunion began at end of 4 days	Immediate result good. No end-result
J A M. (E 300740)	66	Few hours	Diabetes. Fracture of patella and carpal scaphoid	++	Reduction not considered necessary. Fixation with steel only. Early massage and mobilization	Immediate result good. End result not obtained

External Condyle

A C. (O 19891)		Few hours	None	+	No reduction. Fixed in acute flexion	AxPtEa
S M. (O 2588112)	44	Few hours	None	+	No reduction. Fixed in acute flexion	AxPtEa
P K. (O 267 11)	58	Few hours	None	++	Closed reduction unsuccessful. Open reduction performed, no lateral fixation. Elbow fixed in acute flexion	AsPtEa
A S (O 1001117)	37	Few hours	Fracture of tibia	++	Closed reduction performed and elbow fixed in acute flexion for 45 days. At the end of 6 months very little motion of elbow. Operation resection of lateral condyle	AxPtEa Flexion 120° Extension 120° An industrial compensation case
M F (O 2695117)	8	Few hours	Posterior dislocation of elbow	+++	Closed reduction performed. Elbow fixed in acute flexion	AxPtEa
P H (O 27 264)	16	Few hours	Wound over olecranon, not compound	+	Disfranchisement of wound. Closed reduction performed with fixation of elbow in acute flexion	Immediate result good. End result not obtained

TABLE IX.—FRACTURES OF THE CONDYLES OF THE HUMERUS (INTRA ARTICULAR)

Intercondylar (T) Fractures

Identification	Age	Period after injury	Complications	Displacement	Treatment	Result
H.M.C.W. (O. 59155)	12	Few hours	Fracture external malunion	++++	Closed reduction, traction and suspension with elbow in right angle flexion. Poor position	AsFsEs About 1/2 limitation of motion
G.M.C.A. (E. 279227)	12	Few hours	Primary injury of radial nerve. Later recovered spontaneously	++++	Closed reduction unsuccessful. Operative reduction with fixation of condyles by screw. About 1/2 limitation of motion	AsFsEs
A.B. (W. 265119)	20	Few hours	Old ununited fracture of capitulum	+++	Closed reduction attempted on three different occasions without success. Later open reduction performed with fair position but resulted in ankylosis. Excision of elbow performed later	AsFsEs Fair motion but elbow is weak and unstable
E.J. (E. 285921)	15	Few hours	Compound and badly soiled	++++	Debridement performed with excision of the condyles. Fixation in traction and suspension with elbow at right angle	AsFsEs Excellent motion but elbow is weaker than normal
T.H.L. (O. 597780)	70	1 year	Ununited fracture	++++	Compound fracture treated by outside physician with failure of union. On account of age no operation advised. Brace fitted	AsFsEs Patient died 15 mos. later
G.D. (E. 21111)	11	Few hours	Old infantile palsy on affecting arm	++	Closed reduction performed and elbow fixed in acute flexion	AsFsEs
L.Z. (E. 154030)	14	Few hours	Fracture of head of radius	++++	Treated by traction and suspension with elbow in different positions for 3 weeks	AsFsEs
L.R. (W. 155775)	8	14 hours	Fracture of lower end of radius	++	Closed reduction. Elbow fixed in acute flexion	AsFsEs
L.D. (W. 176411)	14	Few hours	None	++++	Closed reduction unsuccessful. Open reduction performed with fixation of condyles by screw	AsFsEs Moderate limitation of extension
F.W. (E. 266114)	40	Few hours	None	++	Closed reduction. Elbow fixed in acute flexion	AsFsEs
E.P. (W. 175411)	10	1 day	Scarlet fever	++	Closed reduction performed twice elbow fixed in acute flexion	AsFsEs
P.O. (E. 295477)	15	Few hours	Feverblinded. Post operative infection	++	Open reduction performed 4 days after injury. Fixation with 2 plates and screws. Developed abscess but no osteomyelitis. Healed after removal of plates	AsFsEs Slight limitation of extension

portions of the articular surface of the humerus. The intercondylar fractures are often of the T or Y type—that is a transverse fracture through the shaft of the humerus at its junction with the condyles combined with a vertical split down between the condyles. These are often accompanied by comminution of greater or lesser extent (Fig. 11).

The condylar fractures are severe injuries and seriously menace the future function of the elbow joint. Extensive pathological changes are produced in the articular surfaces and joint capsule both as a result of the injury and of the reparative process. The displacement on the one hand may be of an extreme type with separation and rotation of the condyles and overriding of the shaft fragment, or on the other may be almost completely absent. Between these extremes all degrees of

displacement may be found. Because of this variation the treatment of condylar fractures is always an individual problem and must be decided after consideration of the nature of the fracture, the extent of the displacement, and the age of the patient.

Our group of condylar fractures comprised 50 cases (11 per cent of the entire group) divided as shown in Table VII. The salient facts about the individual patients are shown in Tables VIII and IX.

It will be noted that a little more than half of the patients (54 per cent) were treated in the Emergency Ward only. All of these were fractures with little or no deformity for whom house admission was not considered necessary. In view of the prevalent impression of the invariable severity of condylar fractures it is a matter of interest to have found among them

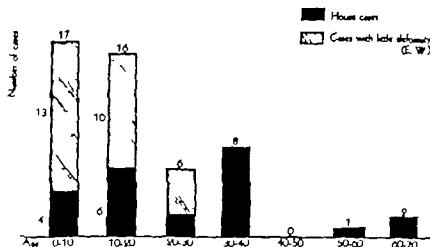


Fig. 1. Fractures of the condyles of the humerus (50 cases) Age distribution by decades

such a high proportion of injuries that appeared to have but slight functional significance. Such injuries occurred chiefly in the first two decades of life while the fractures with deformity reached their peak in the age group between 30 and 40 years.

End result examinations were obtained in 10 of the 23 house cases, and the gradings are shown in Table X. From an analysis of these cases the following conclusions seem justified:

1. The method of closed reduction is of value in the condylar fractures with slight or moderate deformity but is not effective in the comminuted fractures with severe deformity, especially those of the intercondylar type.

2. In condylar fractures with severe deformity the choice would appear to lie between

open reduction preferably with internal fixation of the major fragments by screws or plate or treatment in suspension and traction with early mobilization of the elbow joint. The decision between these methods should take into consideration the patient's age, occupation and general condition and the facilities available for performing technically difficult and potentially dangerous operations upon the bones and joints.

3. Following closed reduction of fractures of the medial condyle, retention of position is favored by the position of acute flexion which secures relaxation of the muscles attached to the condylar fragment. For the same reason in fractures of the lateral condyle the position of complete extension is the more favorable.

TABLE X.—END RESULTS (1 YEAR) AFTER CONDYLAR FRACTURES (INTRA ARTICULARLY)

Method of Treatment	Results				
	Excellent A++ F E	Good A+ F E	Fair A F E	Poor A F E	Unknown
X reduction, fixation only					
Old commuted fracture, brace fitted				Later success	
Closed reduction and acute flexion	3	3		Later success	
Traction and suspension					
Operative reduction		3		3	
X reduction, early motion					
Excision of condyles (early)					
Total	6	7	3	4	3

Immediate results good.

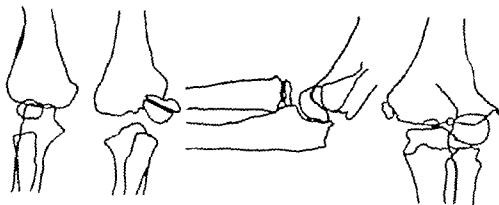


Fig. 13 left Fracture of capitellar epiphysis with small plaque of bone attached. There is moderate rotary displacement. The normal elbow is shown for comparison.

Fig. 14. Same case as shown in Fig. 13 showing end result two years after injury. The capitellar epiphysis was replaced by open operation and sutured. There was no arrest of growth.

4 Following open reduction early mobilization is to be urged and this is facilitated by secure internal fixation of the fragments. Postoperative support is best provided by the application of traction and suspension apparatus. This protects the elbow and also permits mobilization.

5 Skeletal traction by means of a wire (Kirschner) passed through the olecranon may prove of value in the treatment of comminuted fractures of the condyles with deformity but was not used in any of these patients. It offers a means of securing continuous extension in the axis of the humerus while at the same time permitting the elbow joint to be maintained in the position of right angle flexion.

6 Excision of the condyles should not be performed except immediately in certain badly soiled compound fractures as a step in the operation of débridement or late in case of complete ankylosis of the elbow. In the latter condition arthroplasty is preferable to excision and results in a more stable joint.

IV FRACTURES OF THE CAPITELLUM

Two types of injury affecting the capitellum must be distinguished first those involving the epiphysis which occur only in children below the age of 15 and second those involving the capitellar portion of the articular surface in adults. Both are serious injuries but the epiphyseal fracture is the more common and therefore the more important of the two injuries.

IV A FRACTURE OF THE CAPITELLAR EPIPHYSIS

Of the epiphyseal fractures one must distinguish between those with incomplete and those with complete displacement.

Incomplete displacement Many fractures of the capitellar epiphysis are associated with such slight displacement that there is failure to recognize the nature of the injury even upon X ray examination. The patient is dismissed with a diagnosis of sprain or contusion. Adequate protection of the elbow is not provided and it is only later when continued irritation has resulted in persistent pain and stiffness that a correct diagnosis is made.

In order to recognize pathological variations it is important to know the normal anatomic features. In the lateral roentgenogram the osseous center of the capitellar epiphysis projects forward and downward from the humeral shaft and gives an appearance somewhat similar to that of a hockey stick with a shortened head. The anterior surface of the epiphysis forms a continuous line with that of the humeral shaft except for the interruption in the shadow due to the cartilaginous plate. In the fractures with incomplete displacement the epiphysis is displaced somewhat posteriorly and there is a distinct jog in the line of the anterior surface. The roentgenogram must be made with the tube accurately centered so as to produce a true lateral view or this slight displacement will not be recognized. The anteroposterior view fails to show any abnormality the fracture line being invisible since it coincides with the cartilaginous disk.

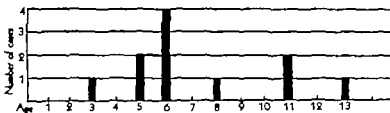


Fig. 15. Capitellar epiphysis fractures (11 cases) Age distribution.

Epiphyseal fracture should be suspected in any child who presents objective signs of injury to the elbow such as pain, swelling, tenderness, and limitation of motion, yet whose roentgenograms at first glance fail to show any evidence of bony injury. The relations of the capitellar epiphysis to the humeral shaft should be scrutinized closely in such cases and a second X-ray examination should be made if any doubt exists as to one of the views being a true lateral one. Films should also be made of the uninjured elbow for purposes of comparison with the normal.

The injury is not of great importance when treated properly. It is unnecessary to correct the displacement, as a rule, as this is too slight to cause any functional disturbance. Exceptions to this rule, however, must be recognized. Fixation of the elbow is, however, necessary preferably in the position of acute flexion. This should be maintained for a period of 2 to 3 weeks following which mobilization may be begun.

Complete rotary displacement. Fracture of the capitellar epiphysis with complete rotary displacement is a distinct clinical entity which has not heretofore received adequate recognition. The mechanism of the injury is apparently a medial or varus deviation of the forearm from indirect violence throwing strain upon the lateral ligament of the elbow which in turn pulls off the capitellar epiphysis, usually with a thin layer of bone attached to the cartilaginous plate. The epiphysis is displaced outward and rotated upside down by the pull of the extensor muscles attached to its lateral surface (Figs. 13, 14).

There is complete loss of contact between the fractured surfaces and failure of union is bound to result unless replacement is secured. This can be accomplished with certainty only by the open method and in our opinion no

other form of treatment should be attempted. Open reduction is easy when performed early; the epiphysis can be fitted back into position and secured by one or two chromic gut sutures passed through the ligamentous attachments and periosteum. Following operation the elbow should be splinted in the position of right angle flexion or partial extension to secure relaxation of the extensor muscles of the fingers and wrist.

Several children with ununited fracture of the capitellar epiphysis have been followed on the fracture service of the Massachusetts General Hospital, and the end results of the same condition have also been seen in adults. There is increasing deformity of the lower end of the humerus over a period of years due to absence of growth from the capitellar epiphysis. The medial side of the humerus outgrows the lateral side and there develops marked cubitus valgus deformity. This not infrequently causes elongation or stretching of the ulnar nerve with late or delayed ulnar palsy, sometimes not coming on until 15 to 20 years after injury. The loose fragment displaces in and out of the elbow joint on movement, and although a fair range of motion is retained, there is instability and loss of power. In patients with ununited fractures of the capitellum who are seen within 3 to 4 years after injury improvement can be obtained by an operation designed to bring about union between the loose fragment and the shaft with the aid of a bone graft, and the benefits of surgical treatment even at this stage should be more generally recognized.

In our group of elbow fractures there were 11 instances of epiphyseal fracture of the capitellum. The ages of the patients varied from 3 years to 13 years but the peak of the incidence was at the sixth year (Fig. 15). The types of epiphyseal injury that were

TABLE XI.—EPIPHYSEAL FRACTURES OF THE CAPITELLUM

Identification	Age	Age of Injury	Displacement	Treatment	Result			
					A	F	E	
Fractures with Slight Displacement								
F.W. (W.284103)	11	6 wks.	+	Fracture healed. Slight deformity. Active use advised	4	3	4	Good
W.B. (E.W.)	5	Fresh	o	No attempt at reduction. Elbow bandaged in acute flexion	4	4	4	Excellent
R.W. (E.293090)	13	24 hrs.	+	Only slight deformity. No reduction. Elbow fixed in acute flexion	3	4	4	Excellent
Complete Fractures with Rotary Displacement								
J.L. (O.253123)	11	Fresh	++++	Closed reduction attempted but was unsuccessful. Open reduction was performed and good position obtained	3	4	4	Excellent
G.R. (E.291825)	6	7 days	++++	Open reduction was performed with complete replacement. Elbow fixed in acute flexion	4	4	4	Excellent
R.W. (E.291774)	6	3 days	+++	Closed reduction attempted but was unsuccessful. Open reduction was performed with complete replacement. Fixed in acute flexion	End-result not obtained. Immediate result good			
M.D. (O.256 10)	3	Fresh	+++	Open reduction was performed with complete replacement. Fixed in acute flexion	End-result not obtained. Immediate result excellent			
L.P. (O.291478)	6	4 years	Non-union of epiphysis	Open operation was performed. Old fractured surfaces were freshened. Bone graft was interposed between fragments to restore normal articular plane. Fragments fixed with 3 steel screws. Elbow fixed by posterior plaster splint in right angle flexion	3	4	4	Good
Complete Epiphyseal Fractures with Lateral Displacement but No Rotation								
J.R. (E.284454)	8	Fresh	++	Closed reductions were performed twice with fixation of the elbow in acute flexion but with little improvement. Patient developed bronchitis, making operative or further attempts at reduction useless	3	4	4	Excellent
F.L. (O.290396)	8	10 days	Post-lat. dislocation of elbow	Atypical lateral rotation of epiphysis. Open reduction was performed with nature of fragment. Excellent position was obtained	4	4	4	Excellent
B.P. (O.297342)	6	25 days	Fracture already united	Considerable deformity. Epiphysis was displaced outward but not rotated. Open reduction was considered but rejected. Active use was advised	End-result not obtained			

encountered together with the methods of treatment employed, and the end results so far as they are known, are shown in Table XI. No instances of arrest of growth were encountered and this is due to the fact that the fracture line passes proximal to the epiphyseal plate instead of through it.

IVB FRACTURES OF THE CAPITELLUM (ADULTS)

Fracture of the capitellum in the adult usually takes the form of a separation of a portion of the articular surface with forward and upward displacement of the loose fragment and the formation of a free body in the joint. Occasionally the fracture is of the compression type, the articular surface being driven upward and impacted into the under

lying bone. The fracture is apparently produced by force transmitted upward through the radius, the head being driven against the articular surface of the capitellum. The fracture is frequently associated with other injuries in the region of the elbow such as fracture of the head of the radius or dislocation of the ulna on the humerus. The treatment depends entirely upon consideration of the individual case. When a loose fragment has been separated, it may be necessary to remove this by open operation, in other types of fracture open reduction may be indicated. It is generally impossible to influence the deformity by closed methods.

There were 3 instances of this fracture in our group of 439 elbow injuries the ages of

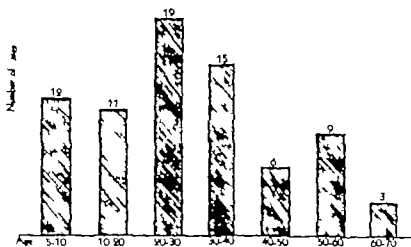


Fig. 16 Upper end of radius fractures (75 cases) Age distribution by decades.

the patients being 42, 51, and 69 years respectively. In one case the fracture was complicated by posterior dislocation of the elbow; this was reduced and the result at the end of 1 year was graded A, F, E₃. In the second case there was an accompanying fracture of the olecranon process. This was treated by operative suture with wire. The patient later died of coronary thrombosis. The third patient was only admitted 4 months after injury at which time there was a bony ankylosis of the elbow. Arthroplasty was performed with the insertion of a free flap of fascia lata, and at the end of 1 year the result was graded A, F, E₃. There was a nearly normal range of motion but some instability and loss of power

elbow they constituted the third largest group of elbow injuries. The accompanying graph (Fig. 16) showing the age incidence of the fracture indicates that it is more commonly an injury of adult life than of childhood and that the peak is reached in the age group between 20 and 40 years.

The injury may be produced either by indirect violence—the force being transmitted along the shaft of the radius and driving the head against the capitellum—or by direct violence acting on the lateral aspect of the upper forearm or elbow. In a fairly high proportion of the cases (27 per cent in our series) the fracture occurs in association with some other injury of the elbow, particularly posteromedial dislocation of the elbow or fracture of the olecranon process. This shows the vulnerability of the head to articular displacements of any kind. The list of complicating injuries is shown in Table XII.

Several different types of fracture of the radial head can be distinguished and their

V. FRACTURES OF THE HEAD AND NECK OF THE RADIUS

Fractures of the head and neck of the radius numbered 75 cases, or 17 per cent of the entire group. After the supracondylar fractures of the humerus and the dislocations of the

TABLE XII.—FRACTURE OF THE HEAD AND NECK OF THE RADIUS

List of Complicating Injuries of the Elbow—75 Patients

Posteromedial dislocation of the elbow (with fracture of coronoid process—5)	8
Fracture olecranon process	10
Fracture upper third of ulna lat. elbow joint	1
Intercondylar fracture lower end of humerus	—
	30 or 37 per cent

TABLE XIII.—FRACTURES OF THE HEAD AND NECK OF THE RADIUS

Types of Injury and Incidence in 30 Patients

Epiphyseal fractures, upper end of radius	3
Flavate fractures of radial head without displacement	3
Fractures of radial head with displacement	11
Fractures of radial neck with displacement	6
Comminuted fractures involving both head and neck	5
Total	30
Compound fractures	3

differentiation is important from the view point of treatment. The list of these together with their incidence in our group of 30 carefully studied house patients is shown in Table VIII.

The epiphyseal fractures numbered 3, or 10 per cent in our group of 30 house patients. Two of the patients were aged 8 years and one 13 years. Below the age of 7 years the epiphysis is largely cartilaginous and able to resist injury and it unites with the shaft at the age of 14 to 15 years so that the age period in which epiphyseal fracture may be produced is relatively short. The osseous center represents only a thin disk of bone and corresponds to the radial head. When the epiphysis is fractured and displaced it is quite likely to become isolated as a loose body in the joint devoid of blood supply. This occurred in one of our 3 patients when no operation was performed to replace the epiphysis. In the 2 other patients open reduction was performed and consolidation in good position was obtained (Fig. 17). No method of internal fixation was employed, the fragment being retained in alignment by the position of acute flexion of the elbow. Obliteration of the epiphyseal cartilage occurred in both cases but no appreciable shortening of the radius resulted since the amount of growth contributed by the upper epiphysis at this age is slight. Table XIV presents summaries of the records of the patients with epiphyseal fracture.

Fractures of the head and neck of the radius, if associated with displacement, commonly cause serious impairment of elbow joint function. Not only does the bony deformity limit or prevent rotation of the upper articular

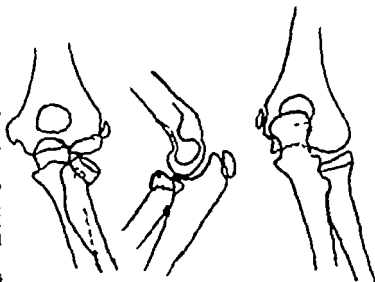


Fig. 17. Epiphyseal fracture of the upper end of radius. A. Roentgen appearance on admission showing tilting of the head. B. Following open reduction. C. Two months later showing union.

element in the lesser sigmoid cavity of the ulna with loss of the ability to pronate and supinate the forearm but there is frequently limitation of extension of the elbow as well. This is due to scar formation and thickening in the anterior capsular ligament usually the result of the displacement of a fragment of bone in this direction. To prevent future disability it is necessary to correct the bony deformity but the situation and nature of the fracture are such as to render it impossible except by open operation. This may take the form of open reduction, excision of the displaced fragments or resection of the entire radial head. When the bony deformity is absent or slight, no impairment of function should follow, and the only treatment indicated is protective splinting for a period of 2 to 3 weeks with gentle daily mobilization.

TABLE XIV.—EPIPHYSEAL FRACTURES UPPER END OF RADIUS

Identification	Age	Age of injury	Complications	Displacement	Treatment	Result (year)			
						A	P	E	
R.E. (W. 566360)	13	2 days	Fracture of olecranon without displacement	Marked +++	Open reduction performed 3 days after injury. No internal fixation. Elbow splinted in acute flexion.	4	4	4	Epiphysis closed
M.E. (W. 57663)	8	6 days	Fracture of olecranon without displacement. Fertilized	Mild ++++	Elbow fixed in slight right angle flexion. Reduction not attempted.	3	3	3	Sequestration lacks 5" or traction lacks 30". Loose body in joint
L.P. (O. 576718)	8	14 days	Grossly comminuted fracture of ulna	Marked +++ Callus present	Open reduction performed. Fragment loosened and replaced. Held in apposition by fixation of elbow in position of acute flexion.	3	3	4	Only about 30° rotation of forearm. Flexion and extension normal

TABLE XV—THE RESULTS OBTAINED IN FRACTURE OF THE HEAD AND NECK OF RADIUS

	Total	Good	Fair	Poor	Unknown
No reduction or operation performed	20	3			3
Open reduction and replacement—Early	3			1	3
Late	1				
Excision of fragments—Early	4				
Late					
Excision of head—Early	3	4	1	0	
Late	4	1			
Total	30	1	6	6	6

In our group of 30 house patients with fracture of the head and neck of the radius operative treatment was employed in 20. The end results in these cases are shown in Table XV. In grading these results the term good was used to designate 75 per cent or better restoration of pronation and supination and of flexion and extension.

Following the study of these cases and an analysis of the end results it seemed fair to draw the following conclusions in respect of treatment:

1. Open reduction ought not to be attempted except in the case of epiphyseal fractures and occasionally in fractures of the radial neck.

2. Excision of loose bone fragments should be performed only in the case of fractures involving the radial head when there is a single fragment and when at least two-thirds of the circumference of the head remains in tact including the inner half that articulates with the ulna.

3. In all comminuted and displaced fractures of the head and neck resection of the head should be advised.

4. Better results are obtained when resection is performed early (within the first 2 weeks) rather than late.

5. A common complication is ossifying hematomas or myositis, particularly in fractures associated with dislocation of the elbow. This may follow resection of the radial head but is not necessarily the result of operation.

6. To guard against this complication at the time of operation it is necessary to obtain

careful hemostasis and to avoid leaving behind any loose bone fragments. (This is a common error.)

7. Following the excision of a single fragment or the resection of the radial head the elbow should be splinted in the position of right angle flexion for the period of 1 week, following which mobilization should be begun.

8. Fracture of the head or neck of the radius is a serious injury and while the prognosis is good for the recovery of an useful elbow rarely is it a normal elbow. On the whole the results in this group of injuries were less good than in any other type of fracture or dislocation of the elbow.

VI. FRACTURES OF THE OLECRANON

Fractures of the olecranon constituted the fourth largest group of the injuries of the elbow and numbered 61 or 14 per cent of the entire group. Of these 33 were treated in the hospital as in patients, while 28 were treated as out patients. For the most part these latter represented incomplete fractures or fractures without displacement. They have been used chiefly for statistical purposes. End-result notes (1 year or more after discharge) are available on 25 of the 33 house patients, or in 75 per cent.

The age distribution of the fracture as shown by the accompanying graph (Fig. 18) is fairly even throughout the various decades, but with the peak in the first three.

The injury may be produced by a fall on the outstretched hand the elbow being in a position of semi-extension, or in rare instances, by direct violence, as from a fall on the flexed elbow or a direct blow. The former is the common mechanism, the olecranon giving way and fracturing as a result of the forcible flexion of the elbow against the resistance of the triceps muscle. In this type of injury the fracture is generally transverse but there may be one or two small fragments in addition to the main ones. The olecranon fragment is generally retracted and separated from the rest of the ulna by the pull of the triceps, especially when the elbow is flexed. Separation of the fragments depends, however upon the extent of laceration of the lateral aponeuroses of the triceps tendon which blend with the fascia of

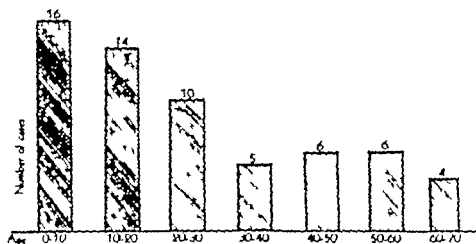


Fig. 18 Olecranon fractures (61 cases) Age distribution by decades

the forearm and provide a second point of insertion for the triceps muscle. When these are intact they limit or prevent displacement. Direct violence tends to produce a comminuted type of fracture and the rarity of this mechanism is shown by the fact that only one example of this was found in 33 fractures. Separation of the fragments sufficient to necessitate operative repair was present in 24 cases, it was slight in 3 and absent in 4.

Complicating bony injuries were present in 14, or 47 per cent of the cases and of these 9 or 27 per cent represented other injuries in the region of the elbow. Fractures of the head or neck of the radius were most common and occurred in 6 or 18 per cent of the patients.

The treatment of olecranon fractures depends chiefly upon the amount of displacement that is present. Fractures without separation may be splinted with the elbow in the right angle position for a period of about 3 weeks but the splints may be removed every day for physical therapy and mobilizing exercises. When the separation is slight good contact between the fragments can usually be brought about by complete extension of the elbow. The reduction should be verified by X ray examination, and when the position is shown to be satisfactory the elbow should be immobilized in this position. Mobilizing exercises should not be started until the end of 3 weeks. When gross separation of the fragments is present we believe that open reduction and suture is the best method of treatment. It has the advantages of securing close approximation of the fragments, of removing

interposing tendinous fibers which interfere with bony consolidation and of securing bony, instead of fibrous union. Operative repair when properly carried out shortens the period of convalescence and obviates the necessity of prolonged fixation of the elbow. It should be remembered however that it exposes the patient to the risk of infection, and that this hazard can be overcome only by skilful surgery and meticulous technique.

We believe that operative repair should bring about such close and firm fixation of the fragments that there should be no need for external splinting, or at the most for splinting of short duration only. Prolonged postoperative fixation with the elbow in extension always results in slow recovery of function and should be avoided. Kangaroo tendon and chromic catgut are inadequate as suture materials and do not provide the secure fixation of the fragments necessary for early mobilization. We have seen several instances of secondary displacement following operation when these materials have been used. Metallic wire, steel screws, or flanged nails may be used successfully for this purpose but for a number of years we have been partisan of the use of living fascia lata suture—a method that has been developed and used extensively by the surgeons of the fracture service of the Massachusetts General Hospital for the treatment both of fractures of the olecranon and of the patella. A fascial strip one half to three quarters of an inch in width is passed through holes one-quarter of an inch in diameter drilled in both fragments, the ends are tied,

TABLE XVI—RESULTS OF TREATMENT OF
OLECRANON FRACTURES

Thirty-three House Cases

	Total	Excellent	Good	Fair	Poor	Discharge not good at discharge
No cases treated with- out operation						1
No cases in which oper- ative repair was done	6				3	3
Total	10				3	3
Materials used for in- ternal fixation						
Wire						
Steel bone screw						
Steel nail						
Chronic caught suture						
Kangaroo tendon suture						
Fascial suture (drill holes)	8					
Fascial transplant over surface	3				anky- losis	
Complicated case of an- kylosis						
Total	16				3	3
Complicated						

and the knot made secure by transection with interrupted sutures of fine silk. Such fascial sutures live and do not constitute foreign bodies. On account of their great tensile strength they secure firm fixation and the elbow may be flexed to the right angle without danger of separating the fragments. No splinting is required beyond the use of large soft dressings. Active motion may be begun at the end of 1 week, and the function is quickly regained. A second method of fascial reinforcement that was tried consisted in suturing the fragments with kangaroo tendon and then laying a free flap of fascia lata over the fracture line on the posterior surface and suturing it to the triceps tendon and adjacent soft tissues. This method seemed less good than the other.

The results 1 year or more after injury obtained by the various types of treatment in our group of 33 patients are shown in Table XVI. It is gratifying to note that in 21 of the 25 patients (84 per cent) these were graded as excellent or good. Of the 10 patients treated

without operation 4 had fractures without displacement and the elbow was fixed only by a sling in 3 the separation was slight and the arm was splinted with the elbow in extension in 2 the elbow was suspended in right angle flexion from an overhead frame. Of the latter 2 patients one had a comminuted fracture without separation and the other an uninfected compound fracture without much displacement. One other patient with an accompanying fracture of the head of the radius was admitted to the hospital 4 months after injury. The head of the radius was excised but the fractured olecranon had healed and did not require treatment.

Open reduction was performed in 23 patients, but 3 operations were required in 1 case so that there was a total of 25 operations. There were 2 postoperative infections, one severe and resulting in ankylosis, the other minor and leading to no functional impairment. The three poor results were caused first by postoperative sepsis leading to ankylosis second by a complicating fracture of the head of the radius the functional impairment here probably being accounted for by this rather than by the fracture of the olecranon and third, by a failure to secure good approximation of the fragments by fascial suture. The latter patient was discharged with what was considered satisfactory although not perfect reduction of his fracture. He drifted into other hands, and 5 months later underwent a second operation on the elbow. When examined at the end of 1 year it was found that the olecranon had been removed there was a complete ulnar nerve palsy and the patient had considerable functional impairment of the elbow. It is fair to question whether this patient would not have had a better result if he had been left alone. One patient with an ununited fracture of the olecranon of 3 months duration required three operations. At the first the fragments were freshened and sutured with kangaroo tendon but the post-operative X rays showed the fragments had re-separated. A second operation was performed 10 days later and the fragments were fixed with wire. Consolidation was obtained with good function but 5 months later re-fracture occurred as a result of a fall. A third

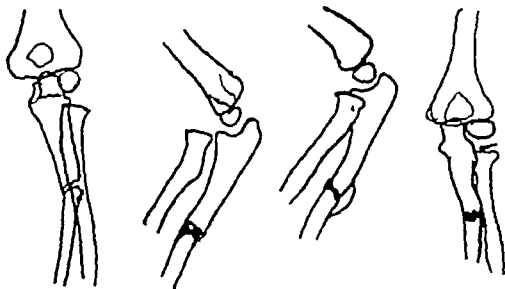


Fig 19. Anterior dislocation of head of radius associated with fracture of shaft of ulna. A and B The deformity at the time of admission. C and D Appearance following open reduction of the head of the radius.

operation was performed and the fragments were sutured with wire and fascia lata. The result at the end of 1 year was graded A, F, L. There were no other instances of refracture. There were 3 compound fractures and in 2 immediate débridement was performed with suture of the lateral expansions of the triceps. Both of these wounds remained clean, and the reduction of the fracture was satisfactory, but the end results are unknown. The third patient was admitted 5 days after injury and the wound a pin point opening remained clean.

It may be said in conclusion that

1 The results of fracture of the olecranon process are in general excellent.

2 The fracture is complicated in about 25 per cent of the cases by other injuries of the elbow and of these the most frequent are fractures of the head or neck of the radius. Such complicating injuries when present modify considerably the prognosis of fracture of the olecranon.

3 Fractures with little or no displacement may be treated with the elbow splinted in extension or supported in a sling at right angle flexion. They may be treated by early massage and mobilization.

4 Fractures with separation should be subjected if possible to operative repair with firm fixation of the fragments by wire screw or fascial suture. Internal fixation should be

secure enough to obviate the necessity of external splinting and to permit active mobilization at the end of one week.

VII FRACTURE OF THE CORONOID PROCESS

In the group of 174 house patients with elbow injuries there were 7 instances of fracture of the coronoid process of the ulna. All of the patients were adult, 2 being in the third decade, 1 in the fourth and 4 in the sixth. Six of the 7 fractures occurred as complications of dislocation of the elbow, and of these 4 were also associated with fracture of the head or neck of the radius and 2 with fracture of the medial epicondyle. In the seventh patient the fracture of the coronoid complicated a fracture of the olecranon process.

The fracture is apparently caused by posterior displacement of the ulna upon the humeral condyles, the projecting tip of the process being knocked off. The small fragment may be retracted upward by the pull of the brachialis anticus muscle, but in our group of patients the amount of separation was never great. Healing may take place by fibrous instead of bony consolidation, but this of itself ought not to result in any functional impairment. The particular menace of fracture of the coronoid, however, lies in the danger of ossification of the hematoma that develops in the region of the fracture and of the anterior capsule. This complication occurred in one of



Fig. 30 Dislocations of the elbow (93 cases) Age distribution by decades

our patients following an operation for an old unreduced dislocation of the elbow. An ossifying hematoma developed and resulted in complete bony ankylosis. We are inclined to feel that this resulted from the operation rather than from the accompanying fracture of the coronoid process. In general fracture of the coronoid rarely needs to be considered from the standpoint of treatment and all attention may be focused on the treatment of the accompanying dislocation or fractures.

Of the 7 patients 3 were treated by reduction of the dislocation and fixation in acute or right angle flexion 2 with fractures of the head and neck of the radius underwent operation for excision of the head of the latter bone. In one of these cases the tip of the coronoid was also excised and this patient obtained a good result. One patient with an accompanying fracture of the olecranon process was treated by operative suture of the ulnar fragments. The results at the end of 1 year were graded as excellent in 3 good in 1 poor in 2 and unknown in 1. Both of the poor results were to be attributed to the accompanying fractures or dislocation rather than to the fracture of the coronoid process.

VIII. DISLOCATION OF THE UPPER END OF THE RADIUS

In the group of 439 elbow injuries there were only 3 instances of isolated dislocation of the

radial head and in all of these the displacement was in the anterior direction. In all 3 patients there was an accompanying fracture of the shaft of the ulna, and in 1 there was a fracture of the olecranon as well. The fracture of the ulna was compound in one instance. The ages of the patients were 8 17 and 28 years respectively. The trauma was a blow or fall on the extensor surface of the forearm.

The radial head is retained in its articulating position with the lesser sigmoid cavity of the ulna by the orbicular ligament, and as long as the ulna remains intact the interosseous membrane also constitutes a strong retaining ligament. For these reasons anterior dislocation is almost invariably accompanied by a fracture of the shaft of the ulna, either in the upper or middle thirds. This association is so definite that whenever a displaced fracture of the ulnar shaft is seen without accompanying fracture of the radius, an X-ray examination should be made of the elbow and a dislocation of the upper end of the radius looked for.

Treatment of the dislocation should take into consideration that either the orbicular ligament has been ruptured in which case operative repair is indicated or that the head has escaped from under the ligament in which case replacement can be accomplished only by operative exposure. Furthermore the relation of the dislocation to the fracture of the ulnar shaft must be borne in mind and reduction of the ulnar deformity must be accomplished simultaneously with that of the dislocation. Open reduction of the dislocation should be performed through an anterior incision after preliminary exposure and isolation of the radial nerve. After replacement of the dislocated bone the orbicular ligament should be sutured and the fracture of the ulna reduced by open operation and plating if neces-

TABLE XVII—ANTERIOR DISLOCATION OF RADIAL HEAD

Identification	Age	Age of injury	Complications	Treatment	Result
J.H.C. (O 17437)	8	1 year	Fracture of shaft of ulna. Temporary postoperative radial nerve palsy	Open reduction and suture of orbicular ligament	A, F, E. Perfect
E.R. (E 308,64)	17	Fresh	Compound comminuted fracture upper third of shaft of ulna late joint	Immediate debridement of compound wound, simultaneous open reduction of head of radius	A, F, E. Incomplete reduction
J.L. (E 34669)	28	Fresh	Fracture of shaft of ulna. Fracture of olecranon	Open reduction of fracture of olecranon with open replacement of radial head	A, F, E.

zary The best position for retention is with the elbow in acute flexion and with the fore arm supinated in order to relax the pull of the biceps muscle Mobilization of the radius in pronation and supination may be started at the end of 7 to 10 days but the fracture of the ulna requires protection for from 3 to 4 weeks

It has been claimed that reduction of the radial head is unnecessary for good function but this is not borne out by our own observations Instability of the head of the radius results and may be painful but in any case is associated with weakness that makes heavy work impossible

The histories of our 3 patients together with the end results are shown in Table XVIII

IX. DISLOCATION OF BOTH BONES AT THE ELBOW

During the 7 year period under study our records showed 93 patients with dislocations of the elbow They constituted the largest class of all the elbow injuries exceeding even the supracondylar fractures and represented 20 per cent of the entire group The age distribution is shown in Figure 20 The peak of the incidence is found in the first two decades and 59 per cent of all the dislocations occurred in this period There is a marked drop in the incidence in the later decades

Complicating fractures in the region of the elbow were very common and were found in 53 patients or 59 per cent The list of injuries associated with elbow dislocations in the 30 carefully studied house patients is shown in Table XVIII From a study of these multiple injuries, it appears that complicating fractures are rare with dislocations in the first decade when the ends of the bones are largely cartilaginous In the second decade they are common due chiefly to the vulnerability of the epiphysis for the medial epicondyle during this period They are rare again in the third decade but after that dislocation is commonly accompanied by a fracture of one of the bony elements—the upper end of the radius the coronoid process external condyle or capitellum

Dislocation of both bones at the elbow may take place in the posterior, medial lateral, or anterior directions, that is the ulna carrying

TABLE XVIII—TABLE OF FRACTURES COMPLICATING DISLOCATION OF THE ELBOW

Thirty Patients Treated in House

	Cases	Per cent
Fractures of elbow in order of frequency		
Medial epicondyle	13	43
Head or neck of radius	7	23
Coronoid process	5	16
External condyle of humerus	3	6
Capitellum	1	3
Fractures as found in combination with other injuries		
Fracture of medial epicondyle alone	11	
Fracture of head or neck of radius alone	3	
Fracture of head or neck of radius and of coronoid process	2	
Fracture of head of radius, coronoid process and medial epicondyle	1	
Fracture of coronoid process alone	1	
Fracture of coronoid process and medial epicondyle	1	
Fracture of head of radius, external condyle of humerus and surgical neck of humerus	1	
Fracture of external condyle of humerus	1	
Fracture of capitellum	1	
Fracture of surgical neck of humerus	1	
Fracture of both bones of the forearm	1	
Epiphyseal fracture lower end of radius	1	

with it the radius may displace from the humerus in any of these directions We believe it is preferable and more in accord with usage in dislocations elsewhere to describe the dislocation in this manner rather than to observe the traditional method which treats the ulna as the fixed point and designates the type of dislocation according to the direction of the displacement of the humerus In the group of 30 house patients with dislocations the displacement was found to be posterolateral in 10 directly posterior in 11 posteromedial in 5 lateral in 3 and undetermined in 1 Thus posterior displacement of one or another type was present in 26 of the 30 patients There were no instances of anterior dislocation and this type usually associated with fracture of the olecranon is known to be very rare In respect to the mechanism of the injury it was impossible to determine the number in which the dislocation was caused by direct violence from a blow or fall on the elbow or in which it resulted from a fall on the outstretched hand The latter mechanism appeared more common

From the standpoint of treatment the first and most important requirement is to make an exact diagnosis of the nature of the injury This ought to be fairly obvious from local examination, but an X ray examination should

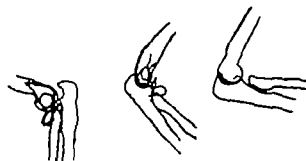


Fig. 31. Posterior dislocation of the elbow associated with fracture of the head of the radius. A. Appearance of deformity at time of admission. B. Following reduction of the dislocation. The radial head is still displaced. C. Following excision of the head of the radius.

always be made to confirm it and to reveal any accompanying fracture that may be present. In spite of this long established rule there were included in the group 6 patients with late unreduced dislocations varying from 28 days to 5 months after injury in which a correct diagnosis had never been made.

Dislocation of the elbow whether or not complicated by fracture requires immediate reduction. Closed reduction becomes increasingly difficult with the lapse of time, and the earlier it is performed the easier it is to accomplish and the less the danger of damaging any of the joint structures. The patient should be anesthetized in order to obtain complete muscular relaxation and to permit of reduction without the use of excessive force. The elbow should be hyperextended to unlock the coronoid process from the olecranon fossa, and while an assistant exerts gentle traction on the wrist, the operator should apply both thumbs to the olecranon and press the olecranon forward. When the ulna lies in a medial or lateral relation to the humerus it should first be pressed into a directly posterior relationship and then reduced. When reduction is accomplished the elbow should be flexed to make the reduction secure, and fixed either in acute or right angle flexion depending upon the amount of swelling and circulatory impairment. We commonly make use of a posterior molded plaster splint for this purpose. Post reduction roentgenograms should be made immediately to make sure that complete reduction has been accomplished and that the relations are normal in both planes.

TABLE XIX.—RESULTS OF TREATMENT OF DISLOCATIONS OF THE ELBOW

	Unre- duced As F E	Good As F E	Fair As F E	Poor As F E	Dis- tances
Fresh dislocations treated by closed reduction	12	5			1
Old unreduced disloca- tions treated by open reduction		2 ⁰	1 ¹	3 ⁰⁰	

⁰Developed ankylosing hematoma with large mass of bone lying outside to head of radius.

¹Unreduced dislocation, 9 days old, complicated by fracture of capitulum treated by open reduction.

²Unreduced dislocation, 90 days old, complicated by fracture of capitulum treated by open reduction.

³Unreduced dislocation, 63 days old, treated by open reduction.

⁴Unreduced dislocation, 36 days old, treated by open reduction.

⁵Unreduced dislocation, 30 days old, completely reduced by closed manipulation.

⁶Unreduced dislocation, 36 days old, complicated by fracture of coronoid process, treated by open reduction. Developed ankylosing hematoma with ankylosis.

In case of fracture of the medial epicondyle one should make sure that the fragment has not become caught in the joint (see "Fracture of Medial Epicondyle") and that there is no evidence of ulnar palsy.

In uncomplicated dislocations the elbow should be immobilized for a period of from 7 to 10 days at which time massage and mobilization may be started the elbow being supported at right angles by a sling. If there is a complicating fracture it may be necessary to prolong the period of fixation, but it is rarely necessary to make it longer than 2 weeks. Fractures of the radial head or neck with displacement when present as complicating injuries should be subjected to operation with excision of the head of the radius at the end of 6 to 8 days.

The special menace of dislocation is calcifying hematoma which usually develops in front of the anterior capsule of the joint. When this process has started very little can be done to check it, but there can be but little doubt that repeated manipulation of the elbow may be a causative or aggravating factor. Forceful passive movements to increase extension of the elbow are particularly dangerous and should be avoided. Whenever there is slow return of function and the motion is painful and guarded the possibility of the development of this complication should be borne in mind and an X ray examination made. If beginning cloudiness in the soft parts anterior

to the elbow is demonstrated then the elbow should be put at complete rest. Operative removal of the calcified mass should never be undertaken until after the lapse of 1 year at which time the ossifying process will have reached a stage of quiescence and there will be less chance of recurrence. In 3 of our 30 house patients, ossifying hematoma developed. It caused restriction of motion and limitation of working ability in 2 and resulted in complete ankylosis in the third. Small areas of calcification in the anterior capsule were noted in 4 other patients and may have been responsible for slight limitation of extension of the elbow.

Of the 30 house patients 24 were fresh dislocations and were admitted from a few hours to 3 days after injury. Reduction was accomplished in all by the closed method. One patient had a compound dislocation the lower end of the humerus coming out through a wound on the anterior surface of the arm. Débridement was performed with reduction of the dislocation immediately after admission to the hospital and the wound healed without infection. There were 6 patients with old unreduced dislocations of the elbow varying in time from 19 to 90 days after injury. Open reduction was performed in all but one. This patient a boy of 12 was admitted 30 days after injury. Closed reduction was performed, but later was discovered to be incomplete. The result in this case was less good than in any other and shows the wisdom of resorting immediately to open operation in any elbow dislocation of more than 3 weeks duration.

The end results more than 1 year after injury are shown in Table VII. When it is

remembered that 24 out of the 30 house cases were complicated by varying types of fracture, it is gratifying to find such a high proportion of good results. They were classed as excellent or good in 20 patients. The immediate results in the 5 patients listed as unknown were good at the time of leaving the hospital. This accounts for 25 cases or 83 per cent of the entire group. Five of the 6 patients with results listed as poor or fair were only admitted 2 months or more after injury. The results demonstrated that when fresh dislocations of the elbow are recognized and reduced immediately after injury the prognosis is excellent, and no functional impairment need be expected.

SUMMARY

An attempt has been made to present a bird's eye view of the various injuries designated under the title 'Fractures and Dislocations of the Elbow.' The different types of injury have been described, the treatment indicated, and attention called to the special dangers that must be avoided in each of the various fractures and dislocations. End result notes made 1 year or more after discharge from the hospital in 176 of the 439 injuries studied have been presented in order to portray as accurately as possible the outcome that may be expected. We feel justified in concluding that fractures and dislocations of the elbow are not formidable when properly understood and correctly treated. They are a challenge to the surgeon's vigilance and skill, but the victory can be won here as it has been in the other domains of surgery by the use of the weapons already at hand when resourcefully used.

APPENDICITIS

SOME OBSERVATIONS BASED ON A REVIEW OF THREE THOUSAND NINE HUNDRED THIRTEEN OPERATIVE CASES¹

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THIS paper is based on the review of 3913 cases of appendicitis in which operations were done in one hospital by many different surgeons, during a period of 30 years. The histories of only such patients are considered as showed definite disease of the appendix, gave a fairly definite history of one or more attacks and were not complicated by other operative procedures at the time of the appendectomy. The cases have arbitrarily been divided into six classes, based on history and operative findings: (1) chronic, those in which the patient had had no definite sharp attack, but rather a grumbling discomfort, and those in which there had been not more than one acute flare up; (2) chronic recurrent, those in which the patient had had two or more definite attacks and an interval operation had been done more or less prophylactically; (3) sub-acute in which the operation was performed during or immediately following either a mild attack, or one which was definitely subsiding; (4) acute unruptured, in a large majority of which the appendix showed gangrenous changes; (5) ruptured with abscess, in which there were definite signs of an attempt to wall off the released infection; and (6) ruptured with peritonitis, in which there was a fairly general or spreading infection with little or no evidence of attempt at localization. (In some instances particularly the earlier cases in which the histories were rather inadequate or indefinite it has been rather difficult to be perfectly accurate in this classification, but in general, the cases more or less automatically fall into their proper groups.) It is not so much the purpose of this paper to discuss the literature, which is far too voluminous to be adequately covered in a communication such as this, nor to boast of or excuse mortality statistics—which as a matter of fact conform pretty closely to many others which have been published—as to search for any differences ob-

servable during this 30 year period, any changes in the character of the operative cases, or in the results obtained and to draw such inferences as may seem warranted from the massed material at hand. It would require much more than our allotted time even to touch on all phases and an endless number of percentages and charts could be offered for consideration, but in this particular study we shall endeavor to limit ourselves to those which have some definite interest or purpose to bring out certain points which seem worthy of special attention or discussion. It is our hope that at some later date we may codify these figures in a more extended and detailed article, if such should seem worth while.

In the cases under review the patients were all operated upon in the old Union Protestant Infirmary and its present successor the Union Memorial Hospital of Baltimore, Maryland between the years 1900 and 1930. There are 60 outside surgeons represented many of them, however by only 1 or 2 cases, and 39 different house surgeons are responsible for the group listed under resident's cases. So that I think we may fairly say that the results are those which may be expected of the average surgeon and not of the superman. There are a total of 3913 cases listed almost equally divided as to sex 2,019 males and 1,894 females. The oldest was 90 years, the youngest 13 months. Of these a total of 3,201—1,647 males and 1,554 females—were operated upon by the visiting surgeons, and 712—372 males and 340 females—by the house staff. In the entire group there were 91 deaths—67 male and 24 female—a mortality rate of 2.35 per cent total, or (and this is an interesting point which will be dealt with more in detail later) 3.38 per cent for males and 1.26 per cent females the former almost three times the latter. Of these 91 deaths, 70 are chargeable to the visiting staff—51 males and 19 females—for

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TABLE I.—GENERAL DISTRIBUTION OF CASES—TYPE, SEX, AND MORTALITY IN FIVE YEAR PERIODS WITH SUMMARIES

5 year period		1900-1905			1906-1910			1911-1915			1916-1920			1921-1925			1926-1930			Totals		
Group	Sex	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate	Cases	Deaths	Mort. Rate
Chronic	F	27	0	0.0	61	0	0.0	65	0	0.0	83	0	0.0	64	0	0.0	113	0	0.0	450	0	0.0
	M	4	0	0	23	0	0.0	70	0	0.0	79	0	0.0	27	0	0.0	85	1	1.15	277	1	0.37
Chronic recurrent	F				90	0	0.0	78	0	0.0	83	0	0.0	75	0	0.0	114	0	0.0	440	0	0.0
	M				5	0	0.0	56	0	0.0	55	0	0.0	49	1	2.04	79	0	0.0	291	1	0.34
Subacute	F	20	0	0.0	31	0	0	29	0	0.0	57	0	0.0	51	0	0.0	106	0	0.0	358	0	0.0
	M	13	0	0.0	34	0	0.0	44	0	0.0	44	0	0	41	0	0	54	0	0.0	240	0	0.0
Acute unruptured	F	34	0	0	80	0	0	35	0	0.0	73	3	3.10	76	2	2.52	143	0	0.0	453	3	0.65
	M	15	3	5.26	65	7	10.75	103	5	4.85	117	5	4.27	119	1	0.84	144	3	2.08	666	13	1.93
Ruptured with abscess	F	28	0	0	57	1	1.75	48	1	2.08	43	1	2.33	25	0	0.0	27	1	3.70	183	3	1.64
	M	4	5	12.5	71	6	8.45	60	2	3.33	39	0	0.0	27	2	7.41	15	2	13.33	283	13	4.60
Ruptured with peritonitis	F	5	18	36	18	8	44.44	16	1	6.25	11	3	27.27	14	3	21.43	10	1	10.0	80	16	20.0
	M	5	1	20.0	20	0	0.0	33	13	39.39	4	2	50.0	20	3	15.0	27	6	22.22	100	27	27.0
Totals	F	159	1	0.63	323	0	0.0	354	0	0.0	334	7	2.09	305	4	1.31	518	3	0.58	1508	4	0.26
	M	69	8	11.59	85	17	20.0	158	8	5.06	115	4	3.48	153	3	1.96	277	13	4.70	1010	67	6.63

(Grand total 1,591 cases—91 deaths—5.72 per cent mortality rate.)

a mortality rate of 2.10 per cent combined, or 3.10 per cent male and 1.22 per cent female, 21 occurred in house cases—16 male and 5 female—with a mortality rate of 2.95 per cent combined, or 4.30 per cent male and 1.47 per cent female. This slight difference might indicate on the surface the advantage of the added years of experience and practise on the side of the visiting surgeon but actually it may be adequately explained by the greater preponderance of the more serious and advanced cases occurring in the house surgeon's group—relatively there were approximately 20 per cent more ruptured appendices on his list than on the visiting surgeons. In fact his mortality rate in handling the latter cases is almost identically that of the surgeon of widest experience and the greatest number of cases on the visiting staff differing by only .04 per cent. This would certainly seem to indicate that in the hands of a reasonably competent surgeon, there is a certain basic minimum rate, below which we cannot go through surgery alone but which must be bettered, if at all, by reduction in the number of such cases which come to operation.

This being the situation, what improvement has been made during the past 30 years

in getting the acute cases before rupture occurs? In considering this phase we will eliminate the chronic and chronic recurrent groups from the figures. This may not be altogether fair, as assuredly the best way to avoid the rupture of an appendix is to remove it before a really acute attack occurs and frankly, the more we see of the results of ruptured appendices the more we lean toward the prophylactic removal of that appendage on the slightest provocation—and we believe we can justify that stand a little later in the course of this paper by ample figures. But for the present let us consider what advance has been made in the early diagnosis and surgical treatment of the acute attack. In the 5 years from 1900 to 1905, in the four groups—subacute, acute unruptured ruptured with abscess, and ruptured with peritonitis—there were a total of 229 cases, of which 105 or 45.85 per cent, had ruptured. From 1906 to 1910 there were 370 with 156 or 42.16 per cent, 1911 to 1915, 353, with 119, or 33.71 per cent, 1916 to 1920 376 with 86, or 22.87 per cent, 1921 to 1925, 383, with 95 or 24.80 per cent, and 1926 to 1930—in the larger new hospital, 644, with 117 or 18.17 per cent. Thus, to be sure, shows a

TABLE II.—COMPARISON HOUSE SURGEONS AND VISITING SURGEONS

	House Surgeons Cases Deaths Rate			Visiting Surgeons Cases Deaths Rate		
Chronic						
Female	63	0	0 0	387	0	0 0
Males	58	0	0 0	319	1	0 31
Recurrent						
Females	64	0	0 0	376	0	0 0
Males	57	0	0 0	234	1	0 43
Subacute						
Females	79	0	0 0	229	0	0 0
Males	42	0	0 0	98	0	0 0
Acute unruptured						
Females	87	1	1 15	376	2	0 53
Males	126	4	3 18	540	9	1 67
Ruptured with abscess						
Females	34	2	2 94	9	4	3 56
Males	49	2	4 08	296	3	5 51
Ruptured with peritonitis						
Females	3	3	13 08	6	13	9 40
Males	40	0	25 0	120	27	22 50
Total females	340	5	47 354	9	1 22	
Total males	372	10	4 50	1647	51	3 10

(Representing 39 house surgeons and 60 visiting surgeons.)

TABLE III.—PERCENTAGE OF RUPTURED CASES TO ACTIVE CASES—BY FIVE YEAR PERIODS

	Cases	Ruptured	Per cent
900 to 905	229	105	45 85
906 to 91	370	150	42 16
19 to 19 5	353	119	33 7
9 6 to 920	376	86	2 87
192 1 to 19 5	383	95	24 80
926 to 930	644	1 7	18 17
Totals	2355	678	28 79

(Number of cases is obtained by adding all those occurring in the subacute, acute unruptured, ruptured with abscess and ruptured with peritonitis groups.)

definite, gradual practically uninterrupted improvement but is it not still a rather sad commentary that in almost 1 of every 5 cases rupture has occurred when the patients reach the operating room? And this in a hospital where a large majority of the acute cases are patients who come from the city proper or the surrounding suburban area, with an abundant supply of doctors, and good transportation facilities. It does seem that we could reasonably expect considerable improvement in this quarter.

Are there any underlying reasons for this state of affairs which we might remedy? We

TABLE IV.—PERCENTAGE OF CASES RECEIVING CATHARTICS (NOT INCLUDING DEATHS)

	Cases	Cathartics received	Per cent
Subacute	99	6	30 65
Acute unruptured	505	205	40 59
Ruptured with abscess	180	109	60 56
Ruptured with peritonitis	91	56	61 54
Totals	975	431	44 21

(Only those cases used in which there was definite statement in history.)

TABLE V.—PERCENTAGE OF CASES WHICH DIED RECEIVING CATHARTICS

	Cases	Cathartics received	Per cent
Acute unruptured	5	20	
Ruptured with abscess	6	5	83 33
Ruptured with peritonitis	26	19	73 08
Totals	37	25	67 57
Totals Table IV	975	431	44 21

Grand totals, Tables IV and V

10 456 45 06

(Only those cases used in which there was definite statement in history.)

TABLE VI.—AVERAGE LEUCOCYTE COUNTS IN SIX GROUPS WITH PERCENTAGE OF POLY MORPHONUCLEARS

	Cases	Average count	Per cent polymorphonuclears
Chronic	93	9 0 7	67 7
Recurrent	79	9 383	67
Subacute	390	9 876	73 9
Acute unruptured	785	16 361	84 0
Ruptured with abscess	233	8 696	84 8
Ruptured with peritonitis	144	7 951	87 6

feel that there are several. In the first place the administration of cathartics in cases of abdominal pain, to which much attention has been directed by various authors. We do not feel that all cases of ruptured appendices are directly traceable to their use, nor do we feel that their exhibition is invariably followed by disaster but there is abundant reason to believe that they are a potent predisposing factor in many instances, and that the avoidance of their employment cannot be too strongly stressed. In our group of cases, only those were tabulated in whose histories there was a definite statement as to whether or not a cathartic had been administered—nothing was taken for granted—consequently only a relatively small number appears in the table. Also probably fortunately for the

TABLE VII—DURATION OF ATTACK BEFORE OPERATION (SURVIVORS)

Group	Sex	Under 6 hours	6-12 hours	12-18 hours	18-24 hours	24-30 hours	30-36 hours	36-48 hours	48-72 hours	72-96 hours	96-120 hours	Over 120 hours	Duration unknown
Subacute	F			8	2	7	1	6	15	7	11	170	15
	M		1	1	1	6		4	15	16	3	161	12
Acute	F	7	45	61	49	50	31	47	52	18	15	10	54
	M	7	60	75	64	51	55	27	70	33	17	17	70
Abscess	F			3	2	7	4	2	13	13	4	15	11
	M		4		0	16	4	66	10	11	5	166	3
Peritonitis	F			1	3	8	1	8	12	11	1	5	7
	M		4	5	4	12	6	10	1	0	11	8	0

individual concerned a fair number of those who were listed as having received a laxative had also a notation of having vomited it fairly promptly. In the subacute group of 199 cases in which a definite statement was made 61 or 30.65 per cent had had a cathartic, in the acute unruptured group of 505 cases 205 or 40.59 per cent in the ruptured with abscess of 180 cases 109 or 60.56 per cent in the ruptured with peritonitis of 91 cases 56 or 61.54 per cent. These all survived operation but among the fatalities though the figures are small the discrepancies are even greater. As there were no deaths in the subacute group only the last 3 need be considered. Of 16 deaths in the acute unruptured group only 5 are listed of whom only 1 or 20.0 per cent had cathartics. Of 21 deaths in the abscess group 6 are listed of whom 5 or 83.33 per cent had cathartics. And of the 52 deaths in the peritonitis group 26—just half—are listed of whom 19 or 73.08 per cent had cathartics. The campaign to educate the layman the druggist and the doctor against the indiscriminate administration of laxatives should be pushed to the utmost. Secondly—and we believe even more important still—the doctor and by all means the medical student should be most forcefully warned of and taught not only the signs and symptoms of the typical case of appendicitis but also the striking absence of such guide posts exhibited in many instances. This latter point we feel is touched on far too lightly when waiting for them to appear means to the patient much the same thing as waiting for the sentinel glands above the left clavicle to clinch the diagnosis of carcinoma of the

stomach. It seems impossible graphically to chart signs and symptoms on an accurate percentage basis in such a way that it would mean anything or be of any great value. Suffice it to say that the cardinal points of constipation generalized pain shifting to the right lower quadrant nausea vomiting point tenderness muscle spasm and rigidity moderate temperature and pulse elevation high leucocyte count with increased polymorphonuclear differential and so forth all these things are present in a few cases a few of them are present in the majority of cases and virtually none of them are present in quite an appreciable number of cases. Of them all the most constant and useful seem to be localized point tenderness and a relative increase in the polymorphonuclear leucocytes—the latter rather than the white blood count taken as a whole. We would take this opportunity to warn against too great dependence upon the white count as an infallible index of the degree of the inflammatory process. Of 1,162 counts recorded in the last 3 groups—acute abscess and peritonitis—93 or 8 per cent were under 10,000 and of these 17 were in cases in which the appendix had already ruptured. On the other hand the average for the counts in the different groups was about as one would expect in 103 chronic cases 9,017, 79 chronic recurrent 9,383, 399 subacute 10,878, 785 acute unruptured 16,361, 233 ruptured with abscess 18,696, and 144 ruptured with peritonitis 17,951. In every group but one—the acute unruptured—the male counts averaged slightly less than the female. The average percentage of polymorphonuclear leucocytes in the 6 groups were 67.7 per cent 67.1 per

TABLE VIII.—DURATION OF ATTACK BEFORE OPERATION (DEATHS)

Group	Sex	Under 6 hours	6-12 hours	12-24 hours	24-48 hours	48-72 hours	72-96 hours	96-120 hours	Over 120 hours	Duration of attack
Acute	F									
	M			1	2	1		1		3
Abscess	F						1		1	
	M						1		1	
Peritonitis	F					1	1	1	1	4
	M						1	1	1	3

cent 73.9 per cent 84.0 per cent, 84.8 per cent and 87.6 per cent, respectively. Thirdly, the all important factor of time. Unfortunately somebody must once have promulgated the theory that an appendix does not rupture in less than 48 hours from the onset of the attack, and much more unfortunately he seems still to have numerous disciples. In point of fact 2 of our series had ruptured in less than 6 hours, 42 at the end of 24 hours and 164 or 24.2 per cent, by the time the 48 hours were up and of these 19 or 11.6 per cent, died. Many of the other cases in the duration unknown group or in those operated upon after a greater time had elapsed would probably fall in this group were all the facts known, but we are dealing only with known facts, and these figures are amply sufficient to prove our contentions namely that ordinarily the time to operate is as soon as the appendix can be reasonably suspected that the use of an 'ice-cap to scatter' the trouble too often does just that, and that the only safe appendix is one in a bottle.

TABLE IX.—MORTALITY RATES IN GROUPS SEPARATELY AND COMBINED

Group	Cases	Deaths	Mortality rate
Group A—early or prophylactic operation			
Chronic	827	1	0.12
Recurrent	731	0	0.14
Subacute	548	0	0.00
Total Group A	2106	1	0.095
Group B—operation during acute attack			
Acute unruptured	1120	16	1.42
Ruptured with abscess	438	20	4.57
Ruptured with peritonitis	240	53	22.08
Total Group B	1807	89	4.925

B is more than 50 times A

It would seem to us much better to remove a half a dozen relatively normal appendices by emergency operations, than to be responsible for the consequences which may attend waiting too long on one.

We fully realize that the statement just made may sound very radical to some, but again we can show that the figures back us up. In the chronic group out of 827 cases there was 1 death—a mortality rate of 0.12 per cent, in the 731 recurrents, 1 death or 0.14 per cent and in 548 subacutes, not a single death. In other words by prophylactic or early operation we can offer the patient a mortality rate—2106 cases with 1 death—of 0.095 per cent. Over against this, if the attack proceeds to the acute gangrenous stage, while the chances are still good—1120 cases with 16 deaths mortality rate 1.42 per cent—the risk has been increased approximately fifteen times—and the appendix still not ruptured. Next in the abscess group—438 cases with 20 deaths, a mortality rate of 4.57 per cent—the danger increases again by more than three times. And finally in the peritonitis group—240 cases with 53 deaths, a mortality rate of 22.08 per cent—we multiply the chance taken by five, a total increase over the early groups of more than 225 times. Is it worth the risk, when the best the patient can look forward to if that particular attack does subside under expectant treatment is the probability of another later one—time, place, and circumstances unknown—plus the ever present chance that the current attack will not subside anyhow? It really seems to us that, paradoxically the radical stand is the more conservative.

But there is one more argument in favor of our contention—what of the time the patient

TABLE A.—AVERAGE DAYS HOSPITALIZATION BY GROUPS IN FIVE YEAR PERIODS

Group	Sex	1900-1905	1906-1910	1911-1915	1916-1920	1921-1925	1926-1930	General average	Average combined years
Chronic	F	18.9	15.8	17.2	15.1	14.7	14.8	15.9	15.5
	M	17.7	12.5	15.4	15.7	14.7	14.4	15.1	
Recurrent	F		12.4	13.8	13.8	13.9	12.0	13.2	12.7
	M		11.7	13.5	13.3	11.5	11.5	12.3	
Subacute	F	17.4	22.3	14.9	12.9	12.5	11.2	13.5	12.9
	M	16.4	12.6	11.4	11.1	11.1	12.1	12.4	
Acute	F	18.7	14.7	13.3	13.6	13.7	12.2	14.7	14.3
	M	17.6	13.0	13.2	13.9	13.6	12.1	13.9	
Abscess	F	30.0	28.2	32.7	29.7	24.5	31.1	29.4	28.8
	M	31.1	30.5	30.9	25.6	26.4	24.9	28.2	
Peritonitis	F	48.6	36.5	39.8	41.8	36.8	25.7	38.1	34.7
	M	35.1	28.1	38.3	28.4	30.0	26.0	31.3	

may reasonably expect to be laid up in the hospital and the consequent economic problem to be faced—not to mention the subsequent period of convalescence which naturally is much longer in the more serious groups of cases, but which cannot be accurately reduced to figures? In the chronic group the average duration of hospitalization was 15.5 days—this figure results from the higher percentage of exploratory right rectus incisions in this group the muscle splitting McBurney incision predominating in the others—in the recurrent, 12.7 days in the subacute 12.9 days, in the acute unruptured 14.3 days in the ruptured with abscess, 28.8 days, and in the ruptured with peritonitis 34.7 days. These figures being averages of course cover the entire hospital stay, in many instances greatly lengthened not only by complications, but also by other subsequent operative or medical procedures in no way related to the appendectomy (Parenthetically by the same token the mortality statistics, as given are not an entirely accurate index, as the deaths include several in no way dependent upon the appendectomy but occurring during the period of

hospitalization and hence indirectly chargeable to it. We hope to remedy these defects at some later date in a paper analyzing the deaths and complications, but at present, time does not permit it.) In all groups the hospitalization for females averaged somewhat longer than for males. Also in all groups the average time for the last 5 year period—1926 to 1930—is appreciably less than the corresponding average for the full 30 year period an indication at least of better surgical and nursing care, as well as fewer and less prolonged complications. But the difference between the unruptured and the ruptured groups remains just as striking.

We will not attempt to summarize these somewhat rambling and at times we fear inco-ordinated remarks, further than to stress once again one fact, which strikes home most forcibly, and which we feel should be given especial emphasis namely, that even in this enlightened and progressive age when public attention is being constantly directed toward various health facts or fancies almost 20 per cent of inflamed appendices have already ruptured when they reach the surgeon

THE HOPEFUL PROGNOSIS IN CASES OF CARCINOMA OF THE COLON¹

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THE assertion is frequently made that carcinoma of the colon is attended by favorable prognosis if the growth is radically extirpated before visceral metastasis has developed. Such has been our observation and experience. A study of 453 cases in which operation was performed at The Mayo Clinic between 1907 and 1927 was undertaken to evaluate the factors entering into the prognosis.

Influences which modify the outlook following surgical treatment of carcinoma of the colon group themselves into extrinsic and intrinsic elements; the former represent general conditions of the host and certain conditions local to the neoplasm, whereas the latter represent the intensity of the malignant cells.

I. Extrinsic influences

1. General

- Age of patient
- Loss of weight
- Anemia
- General debility
- Cardiovascular and renal impairment
- Co-existing chronic debilitating diseases, such as diabetes and tuberculosis
- Duration of growth
- Direction of growth
- Glandular metastasis
- Lymphocytic infiltration
- Fibrosis
- Hyalinization

2. Local

- Site
- Fixation
- Perforation with or without abscess or formation of fistula

II. Intrinsic influences

- Activity of the neoplastic cells, especially their ability to differentiate and approach the normal state

Consideration of these two types of influence, extrinsic and intrinsic, has led us to the firm conviction that the intrinsic malignancy of the carcinomatous cell affects in direct ratio all of the other factors which modify it. We do not feel that clinical scientific observa-

tions and general conditions which influence the prognosis should be excluded from grave consideration, but we feel that it is incontrovertible that the activity of the neoplastic cell is the primary factor which decides between longevity and early recurrence. Unquestionably such factors as involvement of lymph nodes and distant or hepatic metastasis affect the length of life after operation in direct proportion to their presence or absence. We show later in this paper that involvement of nodes is directly dependent on, and that its extent is proportional to, the grade of the malignancy. Such local conditions as fixation of the growth, perforation, penetration and formation of abscess affect the operability of the growth, but they are merely local influencing factors which are usually the result either of intense activity of the carcinomatous cell or of prolonged neglect in the absence of symptoms.

The situation of the carcinoma unquestionably is an important factor. Carcinoma of the right half of the colon, for a reason which we are not able to explain satisfactorily to our selves, is of better prognosis than of carcinoma of the left half. In cases of carcinoma of certain segments of the right part of the colon, for example the cecum, there is a higher percentage of 5 year cures or of freedom from recurrence than when other segments are involved. Such general conditions as anemia, cardiorenal insufficiency co-existing debilitating diseases, and loss of weight obviously are only modifying factors and influence the prognosis by their effect on the condition of the patient.

Age is a very important factor in prognosis. It is a well known fact, proved frequently by many observers, that a youthful host to a malignant growth is at a decided disadvantage compared to a person past middle age. This we believe is explained by the activity of the

tissue cells themselves. The elasticity of youthful tissue in contradistinction to that of senescence is less hostile to carcinoma and more readily succumbs to its invasion.

The size of the growth as has frequently been shown by many observers and our experience corroborates them has little if anything to do with the outlook. The size and pathological type differ distinctly in the two halves of the large bowel and there is no evidence for the conclusion that in the main large growths entail a poorer prognosis than small growths. As a matter of fact it is not uncommon for a surgeon on extirpating a huge growth which he has considered to be on the borderline of operability to find absence of metastasis to nodes and a low grade of malignancy the tumefaction being largely the result of inflammatory reaction. Such types of growth often give the most satisfactory prognosis particularly if they are situated in the right half of the colon. On the other hand it is not an uncommon experience to explore a small rectal or sigmoidal growth which is perfectly operable locally and at the same time to find multiple hepatic metastasis contra indicating resection of the growth except occasionally as a palliative measure.

The factor of direction of growth unquestionably has some bearing on the outcome. It is shown that growths which protrude into the lumen of the bowel give better prognosis by a considerable percentage in a large series than growths which extend toward the serosa. Because these intraluminary growths progress away from the nodes that are in immediate juxtaposition to the bowel and because they are usually of the papillary or adenoid type and therefore of lower grade of malignancy they influence the prognosis favorably. On the other hand the smaller sessile growths which extend toward the serosa frequently are of higher grade of malignancy and metastasize by way of the lymphatic system at an earlier date.

Concerning intrinsic factors the differentiation or lack of differentiation of the carcinoma cells is we believe the most important single influence on prognosis reacting as it does either directly or indirectly on all of the other modifying conditions. The varied mi-

croscopic appearance of malignant cells occurring in the same situation has long been thought to have prognostic significance and conjectures as to the degree of malignancy were based on such observations as the relative number of mitotic figures the staining reaction of the malignant cells and their invasiveness. Among other factors similarly differentiation was suggested but it remained for Broders to call attention to the real prognostic significance of differentiation to prove his contention by large series of cases both of squamous cell epithelioma and of adenocarcinoma and to provide a system for the grading of malignancy which we believe is the most important single factor in prognosis affecting as it does directly or indirectly all extrinsic factors.

Rankin and Broders in 1918 demonstrated that definite correlation exists between the degree of malignancy as judged by Broders system of grading and the ultimate results to be obtained from surgical excision of carcinoma of the rectum. In making a similar study of lesions in the colon we have followed the rules laid down by him in 1920 in his article on the grading of carcinoma of the lip (modified in 1925) in which he evaluated the degree of malignancy in terms of grades 1 to 4.

PATHOLOGICAL OBSERVATIONS

In order to study to the best advantage the influences on prognosis of the pathological variations all other variable factors are to be eliminated as largely as possible. The time that has elapsed between the appearance of the tumor and the date of its removal is of course a very important variant in the matter of prognosis. An attempt to control this factor is made by a rigid selection of cases only those cases being considered in which the malignant growth was resectable in which there was no demonstrable hepatic metastasis and in which therefore closure was made at the end of the operation with a hopeful prognosis. For the same reason cases in which death occurred immediately after operation are also excluded.

From the statistical standpoint only those cases were considered in which patients were known to have died of recurrence or to have

TABLE I.—SIZE OF CARCINOMATA OF PATIENTS FREE FROM RECURRENCE AFTER FIVE YEARS AS COMPARED WITH PATIENTS WHO SUBSEQUENTLY HAD RECURRENCE

	Cecum	Right	Left	Sigmoid
Dead (cases)	37	44	46	93
Size (average)	7.7 cm.	7.1 cm.	6.3 cm.	5 cm.
Cures (cases)	47	59	54	73
Size (average)	7 cm.	7.2 cm.	5.7 cm.	5.4 cm.

been living more than 5 years free from recurrence. In each case of recurrence the exact number of months of postoperative life was known. Thus, the series ranges from patients who died in the second month after operation to patients who were living 24 years after operation. Selected according to the standards before mentioned there were 453 cases available for study.

The surgical pathological specimens were studied from five aspects: (1) size (2) direction of growth that is whether the tumor was projecting into the lumen or invading the serosa (3) involvement of lymph nodes (4) grade of malignancy as determined by degree of cellular differentiation and (5) a comparison of mucoid carcinomata with the more solid forms.

Carcinomata of the rectum and rectosigmoid were not included in this study. Due to the physiological and anatomical differences between the right and the left halves of the colon the series had been divided in accordance with whether the right or left half of the colon was involved, the point of division was the middle of the transverse colon.

The greatest diameter of the growth was considered as the best index in evaluating the effect of size on the prognosis. In Table I is given the average size of the carcinomata of patients who subsequently had recurrences, as compared with the average size of carcinomata of those who obtained cure for 5 or more years. The group labeled right includes the ascending colon, the hepatic flexure and the right half of the transverse colon. The group labeled left includes the left half of the transverse colon the splenic flexure, and the descending colon.

From Table I it is seen that in no group did the patients with poor results have appreciably larger carcinomata than did those who

TABLE II.—RELATIVE PERCENTAGE OF CURES IN RELATION TO SITUATION OF LESION

	Total	Dead	5-year cures	Per cent cured
Right half of colon including cecum	187	81	106	57.6
Left half of colon including sigmoid	266	130	137	47.7
Total	453	220	233	51.3

obtained good results. When the four groups are averaged together it is found that the patients who died of recurrence had tumors which averaged less than 0.2 centimeter greater (measured by the longest diameter) than those of patients who lived more than 5 years. The inference is that size has little to do with the prognosis of resectable carcinomata of the colon.

It is interesting to observe that the growths in the right half of the colon were larger than those in the left half and that those of the cecum were of largest average size, whereas those of the sigmoid were smallest. As will be observed in Table II however the lesions of the sigmoid and left half of the colon not only do not give a better prognosis, but actually give a somewhat poorer prognosis than do the tumors of the right portion of the colon and cecum.

It has been noted that those malignant growths which project into the lumen give a better result than do those of which the dominant direction of growth is toward the serosa. A lesion which projects itself into the fecal stream will give rise to symptoms of obstruction or of bleeding earlier whereas a lesion which invades the serosa will more quickly reach the lymphatic structures and will be disseminated sooner. As FitzGibbon and Rankin have demonstrated, colonic carcinomata not infrequently arise on the basis of polyps, and we found that it is the polypoid carcinomata which assume considerable proportions (while projecting into the lumen) without serosal involvement taking place. From the prognostic standpoint it is of interest to observe that of the 24 cases which FitzGibbon and Rankin reported of carcinomata which demonstrably had their origin in polyps 22 were of the lower grades of malignancy.

TABLE III — DOMINANT DIRECTION OF GROWTH

	Toward lumen		Toward serosa	
Average postoperative life of patients with recurrence, months	32	5	21	9
Percentage of 5 year cures	62		41	

TABLE IV — NODAL INVOLVEMENT

	Right half of colon including caecum (18 cases)		Left half of colon, including sigmoid (266 cases)	
	With nodal involvement		Without nodal involvement	
Incidence	34 per cent		31 per cent	
Average postoperative life of patients with recurrence, months	15	7	25	6
Percentage of 5 year cures	39		66	

In Table III may be seen the results of our study on the direction of growth and it is apparent that carcinomata projecting into the lumen of the colon give a considerably higher proportion of successful results than do those with invasion of the serosa.

When dissemination of a malignant growth through the lymphatic channels begins the first sign of the invasion is usually to be found in the local lymph nodes. When only these first outposts are involved complete surgical removal is still possible but their involvement makes the surgeon fearful that the malignancy has already become disseminated further and that undemonstrable distant metastasis has occurred. In Table IV are presented the results of our prognostic studies in relation to involvement of lymph nodes in colonic lesions.

In a recent study on the prognosis of carcinomata of the rectum Dukes divided the gross specimens into three groups: those with involvement of lymph nodes; those without involvement of lymph nodes but with extension into the serosa; and those without either involvement of lymph nodes or invasion of serosa. He found the prognosis to be best in those cases in which there was not extension and nodes were not involved; next best in the cases in which there was only serosal extension and worst in those in which the nodes were involved. In our cases of carcinoma of the colon the relationship of extension to prognosis was the same but we found nodal in-

TABLE V — GRADING OF MALIGNANCY IN RELATION TO POSTOPERATIVE LENGTH OF LIFE

	Grade			
	1	2	3	4
Right half of colon (187 cases)				
Incidence per cent	16	53	21	10
Average postoperative life of patients with recurrence, months	25	8	22	8
Percentage of 5 year cures	68	60	48	3
Left half of colon (266 cases)				
Incidence per cent	13	67	16	4
Average postoperative life of patients with recurrence, months	33	7	26	5
Percentage of 5 year cures	63	51	30	18

TABLE VI — GRADE OF MALIGNANCY IN RELATION TO INVOLVEMENT OF LYMPH NODES

	Grade			
	1	2	3	4
With nodal involvement (147 specimens)				
Incidence per cent	11	55	23	11
Average postoperative life of patients with recurrence, months	24	6	19	14
Percentage of 5 year cures	47	41	15	25
Without nodal involvement (266 specimens)				
Incidence per cent	16	63	16	5
Average postoperative life of patients with recurrence, months	34	4	27	7
Percentage of 5 year cures	72	60	54	36

volvement to be much the most significant factor.

It is apparent from Table V how close the correlation is between the grade of malignancy and the prognosis not only as concerns ultimate cure but also in the rapidity with which recurrences are fatal.

Pathologically carcinomata of the colon and of the rectum have much in common. It is interesting to observe that more than half of the malignant growths of the colon were of grade 2 and that a similar incidence was demonstrated relative to the rectum by Rankin and Broders.

Having concluded the study of the various individual factors in prognosis it is tempting to correlate each factor with the others, individually and collectively. The possibilities are, however, too numerous and the results would be more confusing than clarifying. One such correlation was nevertheless indulged in, namely the relationship between grading and involvement of lymph nodes.

TABLE VII—POSTOPERATIVE LIFE IN 44 CASES OF MUCOID CARCINOMA COMPARED WITH 409 CASES OF NON MUCOID CARCINOMA

	Mucoid	Non-mucoid
Incidence, per cent	10	
Average postoperative life of patients with recurrence, months	17.6	22.8
Percentage of 5 year cures	43	52

It is noted in Table VI that grades 1 and 2 were relatively more frequent among the specimens obtained from patients who had no nodal involvement whereas grades 3 and 4 on the contrary were relatively more common among the specimens from patients with involved nodes. In view of this observation it is enlightening to compare the percentages of nodal involvement within the individual grades. In grade 1 28 per cent of the specimens were from patients with involved nodes in grade 2 30 per cent in grade 3 36 per cent and in grade 4 53 per cent. This progressive increase in the incidence of involvement of lymph nodes as one passes to the higher grades of malignancy discloses a definite correlation between the microscopic grade of malignancy and involvement of the regional nodes.

Further study of Table VI however disclosed that the grade exerts as much influence on prognosis in the group in which nodes were not involved as it does in the group in which they were involved and that nodal involvement operates prognostically quite as well in any one grade as it does in any other.

In perusing the literature one will observe that there is considerable difference of opinion as to the malignancy of mucoid carcinomata. Many regard the excess of mucinous substance as a degenerative phenomenon. Parham referred to it as an 'uncontrolled function of secretion' and expressed the belief that 'mucous formation is a sign of functional differentiation of the carcinoma cells. Opposed to that view however is the observation of Rankin and Chumley that the mucoid carcinomata which are most undifferentiated structurally secrete the most mucinous material. In view of the variation in opinions, it becomes a matter of interest to study the mucoid carcinomata from the prognostic standpoint.

In the series of 453 cases of carcinoma there are 44 of the mucoid type these are compared

with the 409 cases in which there was no excessive mucinous secretion (Table VII). It is evident that in our series the prognostic difference between mucoid and other carcinomata is not great but that the mucoid carcinomata are inclined to give a somewhat poorer prognosis.

In concluding the statistical part of this paper we call attention to the fact that although the factors noted in the tables operate definitely to influence the prognosis in the average of a series no such uniformity is seen when one individual case is compared with others. What is prognostic for the group is the dominant tendency in the individual case.

PRINCIPLES OF OPERATION AND OPERABILITY

Considering the advanced stage of the disease at which so many perhaps the majority of patients with lesions in the colon present themselves for examination and treatment one must consider as fundamentals of surgical extirpation attention to obstruction, and rehabilitation. Decompression of the colon then becomes the primary object of all treatment preliminary to resection. It is incontrovertible that obstruction in one of its forms is present in more than three-fourths of the cases of growths of the left and middle portions of the colon. The debilitation, anemia, and cachexia following growths in the right half of the colon are secondary physiological disturbances. It is not necessary that obstruction is present in such a form as to cause hypertrophy and dilatation of the bowel proximal to the growth, but simply dilatation to a small degree should be looked on as being evidence of a certain amount of obstruction. It is well known that obstruction and ulceration enormously increase the permeability of the colonic wall. Given a foul ulcerating growth bathed in a bacteria-laden fecal current there is always present a large amount of infection. When factors favorable to increasing permeability are present the pericolic tissues immediately adjacent to the growth are especially tender and the spread of organisms by the examining hand most frequently accounts for ensuing peritonitis.

Local conditions in the bowel, secondary to obstruction, become unfavorable for primary

resection and anastomosis particularly if they are in the left half of the colon. The wall of the bowel is thickened and edematous and the blood supply is encroached on. The blood supply of the colon however is much more constant than usually has been believed. Steward's work in this connection is most enlightening and instructive. Failure of resections of the last half of the colon in the face of slight obstruction perhaps is due in the majority of instances more to infection in the wall of the colon than to failure of the blood supply *per se* although unquestionably both conditions must be given consideration. In most cases of carcinoma of the colon which occur in middle age or late years of life obstruction is followed by a sequence of events which rapidly produces dehydration and undermines vital processes. When one remembers that the patients do not appear for examination until 10 to 12 months have elapsed the fact is appreciated that the malignant offensive has had ample opportunity to effect attainment of nature's mechanism.

Decompression of the colon is accomplished either by medical measures which are favorably instituted against chronic obstruction or even against subacute obstruction but which obviously must be supplemented by surgical drainage in the cases of increasing or acute obstruction. We have found it possible by medical measures to relieve practically all chronic obstruction to such a degree that the patients were in favorable condition for operation but local conditions modify this factor and occasionally it may not be possible to effect decompression in subacute obstruction except surgically. Surgical decompression in the presence of acute obstruction due to carcinoma is best accomplished by blind caecostomy. Following the suggestions in the paper of Burgess published some years ago we have been much impressed by the favorable employment of caecostomy without exploration when the malignancy produces an acute obstruction without premonitory symptoms. If a caecostomy is done by the Hendon method with a bell catheter "Witzelizing" the bowel in its introduction the surgeon may subsequently, after the patient has recovered, investigate the bowel, localize the growth, and

at the second stage explore the abdomen and institute whatever measures of extirpation seem indicated.

Rehabilitation is a second important fundamental in dealing with carcinomata of the colon. Emergency operations are rarely demanded in such cases. The few in which emergency operation is essential need only decompression because of acute obstruction. Consequently these lesions may be considered chronic ailments which permit of more leisurely examination and selection of the optimal time for operation. By overcoming the dehydration and desiccation by blood transfusion and adequate intake of fluid as well as by a nourishing dietary regimen, one feels that operation is undertaken with less risk.

A third feature of the program of rehabilitation after operation has been the institution, as a routine of intraperitoneal vaccination in an attempt to elevate resistance and overcome infection. We have now used this in more than 600 cases and feel that it is a distinctly advantageous procedure. Although it unquestionably is of small value when utilized alone, and when other fundamental principles of selection for operation are disregarded yet in a sequence of events preliminary to operation we believe it has a distinctly important position.

A fourth feature of the attack on carcinoma of the colon has been in our experience, an advantageous one namely institution of graded procedures for their removal. Obviously, it is not necessary in all cases to employ an operation in two or three stages to remove these growths. Certainly, the more sturdy patients with small growths which have been discovered early occasionally may be submitted to resection in one stage with favorable mortality. This is the exception rather than the rule however and we are firmly convinced that a wider range of operability, as well as a more radical type of operation, may be accomplished by undertaking removal in multiple stages.

The right and left halves of the colon, differing as they do physiologically and anatomically are different problems technically when it comes to a question of resection. We believe that the right half of the colon is best removed by an operation in two stages, which consists

of preliminary union of the terminal portion of the ileum and the middle of the transverse colon and at a second stage removal of the entire right half of the colon, 2 to 4 weeks later. The advantage of end-to-side anastomosis is obvious. The object of resection in two stages is to sidetrack an infected growth and drain the right half of the colon while in addition adequate measures of rehabilitation are being substituted. This is not accomplished by lateral union of the ileum and transverse portion of the colon in nearly so satisfactory a manner. A large portion of the fecal current continues to pass over the surface of the carcinoma, and the very object of the maneuver in two stages is largely vitiated.

For growths in the left half of the colon, we have come to employ with satisfaction an obstructive type of resection, which is radical removal of the local growth and the node bearing region in immediate juxtaposition to it leaving a clamp on both ends of the bowel for a period of 48 to 60 hours, and then opening the proximal blade to establish a colonic stoma. The subsequent steps of this operation consist of removal of the diaphragm between the two gun barrels and closure later if necessary. One of us (8) described this operation in a former publication. At The Mayo Clinic it has been employed continuously since with increasing satisfaction in a large group of cases. The mortality rate reported at the time of the original paper has not been maintained at that time one of us (8) reported 31 cases with 1 death. By extending the scope of the operation and perhaps being a little more enthusiastic than was warranted, the mortality rate has risen to 8.6 per cent but the conviction is not without its merits that a mortality rate of less than 10 per cent in resections of the left half of the colon is perhaps justifiable if the figures of operability run about 50 per cent. This form of resection is obviously strongly contra indicated in the face of obstruction and when we have not been able to decompress the colon satisfactorily prior to exploration we have abandoned the method in favor of an operation for drainage such as cecostomy or colostomy followed at a second stage by some type of resection. The resection still may be obstructive resection if

the surgeon wishes the objection being that there is the necessity for closing two colonic stomas occasionally but this is not a serious objection. Also secondary resection may be performed, with anastomosis at the same time.

The old type of Mikulicz operation popularized years ago and erroneously named because it was done first by Block many years before we mention only to deprecate except in a very small and closely selected group of cases. It has the disadvantage of implanting carcinomatous cells in the surface of the wound in about 12 per cent of the cases and the percentage of cures that follows its application naturally is lower than in more radical types of maneuver. Given a weak, elderly patient who harbors a carcinoma in a mobile segment of the colon, whose abdominal wall can be rapidly infiltrated by local anesthesia, and the growth pulled out onto the abdominal wall without exploration manipulation, or sacrifice of the blood supply the old type of Mikulicz operation unquestionably is indicated. Further than in this type of case, it has small utility.

OPERABILITY

Operability is so variable in the hands of different surgeons that it is impossible to do more than lay down certain fundamentals, which are subject to modification. Our standards of operability maintain that if there are no demonstrable growths in the liver or if the growth is not firmly fixed to the parietal peritoneum or adjacent viscera, attempts should be made to remove it unless the general condition of the patient is such that operation offers no chance of success. One might even argue that occasionally growths that are mobile and resectable, and yet have metastasized to the liver should be extirpated. With this view we have no quarrel, and occasionally carry out resection of the growth as a palliative measure. The reason for this is that death from carcinoma of the liver is relatively painless making justifiable the risk of eliminating an obstructing ulcerating carcinoma which may attach itself to adjacent viscera. Involvement of lymph nodes provided the nodes are in immediate juxtaposition to the growth, should not hinder resection. It long has been

recognized that it is impossible to tell by palpation alone, whether a node is involved and microscopic section is necessary for this decision. Also, study of this series of cases proves that many patients with growths which were shown at resection to have invaded the nodes have lived long and useful lives without recurrence. Local fixation not infrequently does rule out resection. This is a problem a surgeon must decide on the individual merits of each case. Not infrequently one may remove a uterus to which a sigmoidal carcinoma is attached, or the top of the bladder or a segment of small bowel or a segment of the stomach, without operative mortality and occasionally with a brilliant result. In the main, however, such operations are palliative, are undertaken with huge operative risk and extreme care should be exercised before they are undertaken to weigh the advantages and disadvantages to the patient of such a formidable procedure.

Percentages of operability, then, are not very satisfactory gauges from which to draw conclusions. So many factors are concerned that their evaluation is difficult. The highest operability on the colonic and rectal service at the clinic, which we have obtained in recent years, is 68 per cent. Rarely has it ranged below 50 per cent and somewhere between those figures is probably a satisfactory estimate of operability. If it can be maintained with the present low operative mortality rate, if we can resect as a routine over a span of years one of two carcinomata of the colon and rectum as they appear, with a mortality rate ranging from 5 to 10 per cent, we probably will have struck a higher standard than is the average in the surgical world.

OPERATIVE MORTALITY

Hospital mortality unquestionably has been satisfactorily decreased in dealing with malignant lesions of the colon and rectum within the last decade. Although a high rate of mortality still is recognized as inevitable in dealing with these lesions certainly, by co-operative care of surgeon and internist by adequate preliminary decompression and rehabilitation by introduction of intraperitoneal vaccination and selection of more suitable types of opera-

tion for each case the immediate hospital mortality has been reduced. Unquestionably the ratio between hospital mortality and operability is an important index in the consideration of end results following radical surgery. Although every effort should be made to extend the horizon of operability to the utmost compatible with reasonable hospital mortality, it inevitably follows that such cannot be accomplished without a death rate ranging from 5 to 10 per cent.

It long has been recognized that not only is carcinoma of the right half of the colon more favorable for ultimate cure following resection, but also that operation can be performed with lower hospital mortality than if the growth is in the left half. It is not our purpose to consider the factors which enter into this, but our experience in this respect parallels that of other surgeons.

In the study of this particular series of 453 patients with carcinoma of the colon, we included only those who recovered following resection, and who were dismissed from the hospital. In order to obtain some idea of hospital mortality, we reviewed the operations done on the right and left portions of the colon at The Mayo Clinic by the whole group of surgeons during 1930 and 1931. In the right portion of the colon, where the choice of operation was ileocolostomy in one or two stages and resection, there were 84 operations with 9 deaths in hospital or a mortality rate of 10.7 per cent. In the left half on the service of one of us (Rankin), from January 1, 1929 to February 1, 1930, one type of operation that was accepted as a standard but which could not, of course, be done in all cases, was obstructive resection, 31 operations were done with 3 deaths in hospital or a mortality rate of 9.6 per cent. Although this is not consonant with the customary mortality, lower with reference to the left than to the right portion of the colon, an average mortality rate of 10 per cent for the whole colon we believe is not unreasonable, provided the operability is not reduced below 50 per cent.

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DIVERTICULOSIS AND DIVERTICULITIS WITH PARTICULAR REFERENCE TO THE DEVELOPMENT OF DIVERTICULA OF THE COLON¹

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THE appearance of diverticula in the body is widespread. The most commonly observed sites are the upper and middle portions of the esophagus, the duodenum, the jejunum (Meckel's diverticulum), the colon, and the bladder. The more unusual sites are the larynx, the lower end of the esophagus, the stomach, the ileum, the ureter, the urethra, and the biliary and pancreatic ducts.

The most satisfactory classification of diverticula is probably that based on their origin, into the congenital and acquired types, because so called true diverticula containing all the layers of the structure from which they take origin may be either congenital or acquired and may eventually change into so called false diverticula. In the latter instance the herniating mucosa and submucosa is the most conspicuous structure present in the false diverticulum.

The large bowel is probably more frequently the seat of diverticula than is any other structure in the body. While large single congenital diverticular sacs in the colon have been described, by far the most common type is the acquired. These may be present in large numbers and may involve all portions of the colon, rarely the rectum, but most frequently the sigmoid colon. As will be shown later, these diverticula may be microscopic in size and consist only of herniation of the mucous membrane through the circular muscle of the bowel or, as we commonly recognize them, they may be the size of a pea or hickory nut and often contain fecaliths. These sacculations of the colon were adequately described by Cruveilhier in 1849, by Virchow in 1853, and Rokitsky in 1856. According to Sommering they were also described in Matthew Baillies' *Morbid Anatomy* in 1794.

The incidence of the involvement of the colon in diverticulosis can perhaps be best emphasized by quoting the report of W. J.

Mayo, in 1930. In this report 2,139 cases were considered. Five to 7 per cent of all colon examinations revealed diverticula. Spriggs and Maxer report that diverticula of the colon were shown in 8.3 per cent of all the patients subjected to gastro-intestinal X-ray examinations. In the Mayo group it was estimated that 5 per cent of adults over 40 years of age have diverticulosis of the colon, whereas, such a diagnosis was made in only 28 patients under 40 years of age. Hartwell and Cecil have reported 2 patients, 7 and 10 years of age, respectively, and Ashhurst 1 patient, 7 years of age, with diverticula of the colon.

The two outstanding etiological factors seem to be age and constipation. Adiposity has been mentioned as a predisposing factor, but diverticulosis of the colon has been observed in many thin patients.

The factors underlying the development of diverticula of the colon have received much thought. There are several anatomical arrangements in the colon that may predispose to diverticulosis. Poirer and Charpey have pointed out that the three longitudinal muscle bands or *tinea* of the colon include practically all of the longitudinal muscle of the colon. Between these *tinea* isolated bits of longitudinal muscle may be found, but in the main the muscularis in these areas is composed of circular muscle alone. The pleated or gathered appearance of the colon is due to the formation of three rows of sacculations between the longitudinal muscle bundles (Fig. 1). These sacculations are separated by falseform ridges (Fig. 2) composed of all layers of the intestine, as much mucosal as muscular. The circular muscle is reinforced in them and augmented in volume. These sacculations and ridges of the colon retard the passage of feces and in constipated subjects Charpey observed sacculations of large size, like diverticula, which really were but exaggerations of the normal structures.

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In addition anatomically, the penetration of the muscularis by the blood vessels seems to offer areas of weakness in the bowel wall. Klebs first called attention to the possibility of diverticula developing through the areas of penetration of the muscularis by the vessels, and emphasized traction on the mesentery by a faeces loaded bowel as a factor in increasing the size of the vessel openings. Ernst Graser studied this phase of the subject very carefully making serial sections of the bowel wall along the mesenteric attachment. He found several microscopic diverticula which were herniations of the mucosa through the circular muscle. He emphasized as an important factor in the development of diverticula passive hyperemia which dilated the veins and so increased the space of their penetration through the muscularis of the bowel. He wisely observed however that diverticula are not always associated with passive hyperemia. In adverse comment on the theory of Graser Sudsuka studied the sigmoid in 28 heart cases all suffering with passive hyperemia and found diverticula in only 6. He examined 12 other cases of diverticulosis where no passive hyperemia existed.

Von Hansemann observed at autopsy an old man of 85 years who had over 400 diverticula of the ileum jejunum and sigmoid. In the ileum the diverticula were at the mesenteric attachment and at the site of the penetrating vessels. In the sigmoid they were at the antimesenteric border at either side of the tinea where there was little or no relation to penetration of blood vessels.

Considering these points experimentally Herchl Hannon and Goode injected water under pressure into the intestines of corpses and found that rupture of the bowel took place at the mesenteric border. In live dogs, however the same experiment resulted in rupture at the antimesenteric border (Clumpsky Beer). It will also be remembered that when a compressed air hose has been applied to the anus in spirit of playfulness and the colon has been suddenly forcefully dilated rupture of the colon has usually occurred opposite the mesenteric attachment.

Edwin Beer in a most excellent critical review points out that, while the venous

channels through the muscularis may be factors in the development of diverticula at the mesenteric border in diverticula of the colon their most frequent site of development is on either side of the tinea opposite the mesenteric border and into the appendices epiploicae. He believes that muscular deficiency is an important factor. This may be due to wear and tear of age, constipation or muscle degeneration and that through weakened areas by reason of pressure from within caused by constipation, diverticula develop.

Wolf has recently advanced a new theory that due to a disturbance of the neuromuscular system of the intestine there is a dysfunction of the rhythmical contractions of the segments of the large intestine. Eventually a small piece of mucosa is caught up between muscle bundles and forms the beginning of a hernial protrusion.

We have recently studied histologically a number of sigmoid colons containing small diverticula without inflammation as well as the colons of aged subjects in whom no clinical suspicion of diverticulosis existed. It is an interesting fact that if one carefully observes the sigmoid colon of old people at autopsy the normal sacculations (*bossulae* of Poirier and Charpey) are markedly developed and from these can often be expressed small round balls of fecal material. The sections of such bowel taken between the tinea opposite the mesenteric border frequently show microscopic diverticula which do not follow the vessels through the muscularis and consist of herniations of the mucosa and submucosal muscularis and fibrous tissue through the circular muscle (Figs. 3-4). These diverticula show no evidence of inflammatory reaction about them and from the outside of the bowel their presence could not be suspected except in a few instances where small fecaliths may be seen as dark spots in the subserosal fat. These diverticula are really microscopic in size and as far as can be ascertained cause no symptoms and histologically have no evidence of inflammation about them. We believe that they are of frequent occurrence in the old and are a rather common accompaniment of muscular changes, such as the fatty degeneration which occurs in the bowel wall of old

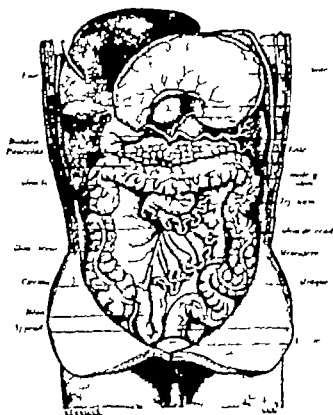


Fig. 1. Drawing showing the sacculated appearance of the large intestine due to ridges composed of circular muscle and mucosa shown in Figure 2 (From Poirier and Charpey)

people. That these diverticula finally protrude through the entire thickness of the bowel wall and usually into the appendices epiploicae is well known. Even at this stage where the neck of the sac penetrating the bowel wall is small and the pouch outside the muscular portion of the bowel wall is the size of a pea and contains a faecalith, evidence of inflammation may be entirely lacking (Fig. 5). Histologically it is seen that the convexity of the diverticulum is covered with mucosa, muscularis mucosa, and the fibrous tissue under the mucosa, but that circular muscle is entirely lacking and that only occasionally a few fibers of the longitudinal muscle is present. It is very easy to see that when inflammation takes place within this sac, it may be the cause of inflammatory processes outside of the bowel wall, such as adhesions, abscess formation, fistula in the neighboring structures, etc. In the histological sections there are areas showing the vessels penetrating the circular muscle of the bowel and creating a real break

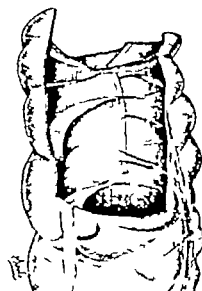


Fig. 2. Falsiform ridges between the longitudinal muscle lines formed by circular muscle and mucosa which cause the pleated or gathered appearance of the colon (From Poirier and Charpey)

in the muscularis without any tendency for the mucosa to herniate through the muscle (Fig. 6). Conversely along the neck of the diverticulum penetrating the circular muscle there is no particular evidence of large blood vessels (Fig. 7).

It appears then that, in the aged conditions exist in the muscularis which allow an easy herniation of the mucosa and submucosa. This hernia goes between circular bundles and is at first surrounded by them. After completely penetrating the muscularis, the periphery of the sac is covered by mucosa and submucosa consisting of the muscularis mucosa, and fibrous tissue and over this the subserous fat. As the diverticulum increases in size it commonly insinuates itself into the base of an appendix epiploica where the body of the sac enlarges into a globular structure and commonly contains dry faecal material or a real faecal concretion. The neck of the sac is small as it penetrates the muscularis and the opening into the bowel may be very difficult to see. During this whole stage of development no evidence of inflammation may be present in histological study, though it is logical to assume that ideal situations exist for inflammation in the body of the sac, which has a narrow opening into the bowel and may be easily occluded.



Fig. 3. Microscopic acquired diverticulum of the colon opposite the mesenteric attachment between the longitudinal muscle thus penetrating the circular muscle. Irregular mucosa covered with muscularis mucosa and some circular muscle fibers. There is shown no evidence of inflammation.



Fig. 4. Small acquired diverticulum of colon completely penetrating bowel wall into appendix epiploica. Circular muscle of bowel shown extending part way up sides of the sac and well developed muscularis mucosa completely covering sac. a, Appendix epiploica b circular muscle c muscularis mucosa.

The pathology, symptoms and treatment of diverticulitis will be considered under one head because the symptoms and their treatment depend on the particular pathological process present in any given case.

The literature contains many splendid contributions which will be here but briefly gen-

eralized (Edwin Beer, Hartwell and Cecil, Watson, Alummery, Spriggs, Telling and Gruner, Telling, Judd and Pollock, Case, Rankin and Brown and W. J. Mayo). Mayo's classification will be followed as it seems to be not only simple but the most inclusive.

1. *Self-limited diverticulitis* is the most common type (Figs. 8-9). The inflammatory process is limited to the wall of the sac and is characterized by recurrent attacks of abdominal soreness, cramps, irregular bowel habits and gas formation. Because of the feeling of incomplete or unsatisfactory bowel movements, the patient takes cathartics or falls into the hands of a "colonic flusher," both of which habits are bad. The treatment consists in the exclusion of seeds, bran, nuts, coarse undigestible material, and the inclusion of cooked fruit, finely divided cellulose vegetable in the diet. Local application of heat and the tincture of belladonna will relax bowel spasm and control the pain in most instances. The patient should lead a *parafin life* (DeQuervain) taking mineral oil daily. While cure of this condition is not possible by following the above regimen the



Fig. 5. a Well defined acquired diverticulum of colon herniating through circular muscularis and containing fecal material. b Evidence of inflammation. c Penetration of vessels through circular muscle without any tendency to diverticulum formation. d Beginning microscopic diverticulum.

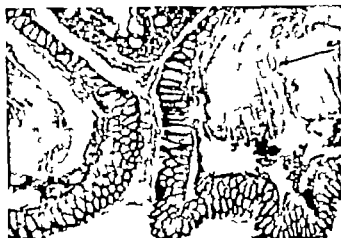


Fig 6 Neck of diverticular sac penetrating circular muscle of colon but with no evidence of large blood vessels accompanying the sac. At a blood vessels penetrating the circular muscle layer without tendency for herniation of the mucosa.



Fig 7 Well defined acquired diverticulum of colon completely penetrating the circular muscularis. No evidence of large vessels accompanying the herniation of mucosa and submucosa.

patient usually gets along with reasonable comfort. It should be emphasized that cathartics and large enemas are the worst possible agents to employ.

2 *Peridiverticulitis* A The process may be acute with sudden onset, leading to perforation with peritonitis. Here the symptoms and treatment are the same as in acute perforative peritonitis except that the process is on the left side.

B The process may be chronic with recurrent attacks of local peritonitis with adhesions which occasionally involve the bowel in kinks or volvulus. The symptoms in this group are of local peritonitis or of chronic or acute ileus. In the former the treatment is expectant and palliative and in the latter operative if the process is acute or interferes to a serious degree with intestinal function.

3 *Diverticulitis and peridiverticulitis with abscess formation* may result in entero-intestinal, enterovesical, (Fig 10) enterocolic, or other fistulae. Local abscess formation or retroperitoneal abscess formation beneath the sigmoid or caecum (Fig 11) may give symptoms similar to perinephritic or appendiceal abscess. In this unusual type of extraperitoneal abscess formation the relation to diverticulitis must be kept in mind in order to make a diagnosis. If the process is subacute and a large mass develops, there may be evidence of ileus and a colostomy above the process will be indicated. In enterovesical

fistula this is often desirable and after the acute inflammatory process has receded, the fistulous communication can be disconnected by operation (David). When the process is acute the resemblance to appendiceal abscess or perinephritic abscess makes a differential diagnosis difficult or impossible. Retroperitoneal drainage should be carried out.



Fig 8. Large acquired diverticula of sigmoid colon.



Fig. 9. Multiple diverticula of colon, especially involving sigmoid.



Fig. 11. Large diverticula of ascending colon which had suddenly penetrated the bowel and resulted in a retrocecal abscess which simulated acute appendicitis under which diagnosis the patient was operated upon.



Fig. 10. Multiple diverticula of colon with filling defect at a due to chronic inflammatory narrowing and accompanied by an enterovesical fistula at that point. A subhepatic abscess developed later from diverticulitis of the hepatic flexure of the colon.



Fig. 12. Filling defect of sigmoid colon due to inflammation and fibrosis of the bowel by reason of multiple diverticulitis.

4 *Diverticulitis associated with obstruction of the bowel*, giving the symptoms of tumor filling defect in X ray (Fig 12), and in 5 to 10 per cent of the cases blood in the stool (Spriggs) makes a differential diagnosis from carcinoma of the bowel very necessary. The pathological process is one of chronic inflammation of the bowel wall around the diverticula, resulting in fibrosis of the bowel wall and narrowing of the lumen of the bowel. The differential diagnosis from carcinoma is not easy and may be impossible to make. The chronicity of the lesion, the presence of other diverticula, and the absence of blood and pus in the stool favor diverticulitis. The correct diagnosis can be made only at operation in some cases and Daniel Jones properly emphasizes the necessity for operative exploration when bleeding from the bowel is from high up and there is a filling defect in the colon. In differentiating diverticulitis with bleeding from carcinoma of the colon Jones points out that the surgeon will be in error more often if he fails to explore such patients. If the fibrosis of the bowel from diverticulitis reaches the point of obstruction and symptoms of obstruction are present the bowel should be resected, usually after a preliminary caecostomy.

5 *Diverticulitis with carcinoma*. If there is a causal connection between diverticulitis and carcinoma it has not been clearly demonstrated. That diverticulosis and diverticulitis are often noted in the presence of carcinoma is well known and diverticula in close relation

to carcinoma is also observed. It is safe to say that the relation of chronic inflammation to carcinoma is much the same in the bowel as it is elsewhere in the body. The important principle is that early exploration is warranted if any suspicion of carcinoma exists.

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HISTORY AND DEVELOPMENT OF THE SURGICAL TREATMENT OF FACIAL PALSY¹

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THERE is a trite saying that "the face is the mirror of the soul."

The crude drawings by the earliest artists as well as the finest portraits by the great masters of painting have depicted character or the state of mind of their subjects, not alone by their positional attitude, but in addition by the expression of the face. Ever since there have been written records, descriptions of facial expression have been employed to portray characters or moods. The historian, the poet, the dramatist, the writer of fiction, the story teller have all leaned quite as heavily on descriptions of facial expressions to depict the vagaries of mind of their characters as they have on the recital of what these persons have said or done.

The constant emotional response in the facial muscles to the vagaries of mind of an individual gradually molds his visage into an almost unmistakable type, certainly evident to a practiced physiognomist and usually as well, to his sophisticated fellow beings.

Volitional changes of expression also are very manifest yet it is the constant play of emotional expressions rather than the voluntary movements which bring about the facial configuration that characterizes the individual.

My present discourse deals exclusively with the lesion known as facial palsy. I need hardly dwell upon the intense misery experienced by the victim. Inasmuch as he or she is deprived completely of what we may call "the language of facial expression," the whole social life of the sufferer is threatened and in many instances the capacity for self maintenance is seriously impaired if not entirely lost.

In my examination of the multitudinous case reports, I have noted that the French observers depend largely upon the word *grotesque* to describe the facial appearance of the patient.

Considering the pitiful nature of the results of the lesion it is not surprising to find, in the

medical literature dealing with the subject evidence both of the deepest sympathy on the part of the surgeon or physician and an eager grasping at any remedy that promises complete or even partial recovery.

In a chronological bibliography beginning in the year 1776 which was prepared for me at the New York Academy of Medicine, I found myself confronted by some 1829 articles, all dealing with facial palsy. Some of these articles are merely case reports others deal with the probable cause of the lesion others with the then accepted remedies.

Up to the year 1879 there is no recorded attempt to "cure" facial palsy by surgical methods. Drobniak at that time anastomosed the spinal accessory to the facial (10).

Occasionally there is keen vision into the possibilities of surgery based on recoveries which followed spontaneous or surgical cures of suppurative conditions in the middle ear or mastoid bone.

The writings of that great observer Sir Charles Bell well over a century ago will always be a delight and inspiration to all who may be interested in this particular field (3). His classical work published in 1822 on *The Anatomy and Philosophy of Expression* embodies an analysis of emotional and voluntary expression in man and animals based on a very exhaustive anatomical and physiological research. He pointed out the elaborate system of muscles provided for the infinite shades of emotional expression in humans as compared with the simpler outfit provided in the lower animals to meet their requirements.

About the year 1890 keen observers in the treatment of facial palsy had discerned that when the lesion had resulted from suppurating ears or mastoiditis recovery from the paralysis often followed the arrest of the purulent discharge whether this occurred spontaneously or by operative interference.

When surgery of the temporal bone had so advanced that operators no longer feared to



Fig. 1 At time of operation, March 18, 1931



Fig. 2 In repose 14 months later



Fig. 3. Showing emotional response 14 months later

invade this particular region the results were two-fold on the one hand there were those who were possessed of an extreme fear lest they should even touch the facial nerve. Facial paralysis must be avoided at all costs! On the other hand there were those who fired by overenthusiasm or overconfidence, were less cautious. Consequently unskilled surgery of the temporal bone brought with it an ever increasing number of cases of accidental facial paralysis.

Confronted by these lamentable facts in the next decade constructive efforts to repair the palsies resulting from these accidents were made by several men.

As early as 1895, Sir Charles Ballance (1) united the distal end of a divided facial nerve to the side of the spinal accessory nerve. The face responded a few months later to faradic stimulation and there appeared a partial voluntary control of the facial muscles together with marked associated movements of the shoulder. In 1898, Faure (12) united the facial to a branch of the spinal accessory. Then followed in rapid succession experiments by Barrago-Ciarella (5) and Manasse (18). Their efforts were confined to anastomosis of the facial nerve with adjacent nerves in the neck.

Without attempting to give a complete survey of this work, I may mention Ballance

Watson Williams (22) and Colledge in England, Gluck (14), Kummer (16), Koerte (15), Tilmann (21) in Germany, and Austria, Harvey Cushing (9), Frazier and Spiller (13), Keen, Taylor, Elsberg, Beck (6), Adson, Lillie Learmonth, in America, and Faure in France.

Improvement in technique and selection of better nerves rapidly advanced so that today we are witnessing the very best results that can ever be expected in the realms of anastomosis in the surgical treatment of facial paralysis.

By the brilliant efforts of these and many others along similar lines, it has been definitely demonstrated that a successful anastomosis of a neighboring nerve to the facial nerve can restore the contour of the face in repose, and by education can to a limited extent, bring about voluntary controlled facial movements. The nerves at first employed were the spinal accessory, the descendens noni, the hypoglossal, the glossopharyngeal.

It was discovered too, that, with a few exceptions, the hypoglossal was more satisfactory than the spinal accessory, that, in turn, the glossopharyngeal was better than the hypoglossal. While improvement in the technique of these various anastomoses brought about better functional results it was nevertheless noted that there remained two adverse factors to be considered. First, the



Fig. 4. Before operation
June 25, 1932



Fig. 5. In repose, May 15, 1933



Fig. 6. In action, May 3, 1933



Fig. 7. Before decompression,
March 10, 1932



Fig. 8. In repose, three months later



Fig. 9. Showing emotional response, three months later

inevitable associated movements marred the results and, second, even in the most successful cases there was an entire lack of emotional expression. And emotional expression as we all know is a very important element in the daily contacts of a human being

In these circumstances surgeons were still dissatisfied. In 1930 Sir Charles Ballance invited me to collaborate with him in an effort to improve the method of operative treatment of facial palsy. Aided by generous contributions from four foundations and a few

personal friends, we constructed an animal laboratory at my country place where we carried out our experiments. The result of our work presented to the American Otological Society in June, 1931 was published in the *Archives of Otolaryngology* (2).

We carefully and conscientiously repeated all the anastomosis operations here mentioned. We added anastomosis with sensory nerves which was successful in restoring facial control marred by no associated movement.

But motor restoration by this method remained slow and incomplete and again we were confronted by the fact that there was no emotional restoration. Gradually we evolved the idea that a direct repair might overcome these deficiencies. Hence we employed autoplasmic grafts—bridging the gap from the proximal to the distal segment of the divided facial nerve with grafts from the following nerves: (1) reversed facial, (2) external respiratory (Bell's), (3) intercostal, (4) descendens noni, (5) median cutaneous of the arm, and (6) great auricular.

In a large series of animals we were uniformly successful in restoring the facial function by introducing grafts taken from either motor or sensory nerves. Moreover we demonstrated that we might use a graft of any length, reversed or unreversed according to the demands of circumstances. Nevertheless in reporting the results of operations on these animals, we could make no categorical statement with regard to restoration of emotional expression. As far as we could judge, emotional expression of the comparatively limited nature exhibited by primates and cats was unimpaired, but not until we could operate for the benefit of humans could we be satisfied that this method of repair would meet all their higher requirements for the nuances of emotional expression.

I wish to state here that this is by no means an entirely new idea. It has long been known that the function of a divided nerve might be restored by the introduction of a graft into the gap, it has been employed in the soft parts for many years. Success moreover, has followed upon the use of grafts in other regions much longer than any which could ever possibly be required in the repair of an injured

facial nerve. The reason that it was not long before attempted was clearly because the facial nerve in its course through the temporal bone is enclosed in a bony tube of ivory like density.

The idea of repair within the temporal bone had already been suggested by Ney (20), Martin (19), and Bunnell (7). As a matter of fact the very idea of employing a long graft from the sural nerve was suggested by Dr. Bunnell, of San Francisco in 1925. I have since learned that he actually employed such a graft in 1930 and that the operation resulted in partial recovery of facial function which is still improving. However, we were quite unaware of his work until it was called to our attention after the publication of our paper (2).

The accompanying pictures taken from moving picture films made of 3 cases selected from a series of 13 cases, illustrate a wide variety of intratemporal repairs.

The first was a baby who suffered an accidental removal of 27 millimeters of facial nerve. This was repaired by a graft from Bell's anterior respiratory nerve 48 hours after operation (Figs. 1, 2, 3).

The second was an adult patient. In this instance 30 millimeters of nerve was accidentally removed in the course of a radical operation. Repair was done 11 months after injury. Bell's anterior respiratory nerve, 30 millimeters, was excised and immediately transplanted (Figs. 4, 5 and 6).

The third film was made of a child who suffered an injury of the nerve by fracture and compression of the fallopian canal. The nerve was uncovered and the sheath was slit over an area of 10 millimeters. Decompression only was done. No graft was necessary (Figs. 7, 8 and 9).

With these and a number of other successes which I reported at the annual meeting of the American Laryngological, Rhinological and Otological Society (2) I believe that a method of dealing with facial palsy has been presented, which offers sufficient improvement over the methods of anastomosis of the facial with other nerves to warrant the discontinuance of that method except in very rare instances.

However often while contemplating the manner of progress and the varying speed of improvement at different stages of the recovery in both animals and humans, certain phenomena kept obtruding themselves into my thought arousing three questions for solution

First, why in all the grafted cases, was there a long period of inactivity followed by a beginning slight response in the muscles and then, directly after this a rapid—almost tumultuous—improvement?

Second why did this same phenomenon occur when the ends of a freshly severed nerve were simply brought together with no intervening graft i.e. the same relative period of delay followed by beginning recovery and then tumultuous recovery—even though the actual elapsed time from injury to recovery might have been much shorter?

Third why when the graft was interposed did the length of time of the delayed response vary according to the length of the graft? Why after faint response first appeared, did the subsequent tumultuous—final complete—recovery take place in about the same added time in all cases regardless of whether the previous delay had been of short or long duration?

Now the answer to all these queries is to be found in the stupendous and splendid research in nerve degeneration and regeneration which has been going on for 40 years. Even earlier than this as far back as 1873 Létrévant (17) had done some work on the union of nerves which stimulated Ranvier (8) and Vanlair (8) Foreman (8) Ballance and Stewart (4) in this research. Then came a host of ardent workers, each adding much to the knowledge of the subject which, in its very nature presented almost insuperable difficulties (8).

There developed two schools whose disciples agreed as to *what* took place—but *not* as to *how* it took place. The contestants have some of them been calm and open minded others belligerent and unyielding.

Leaving out of the question for the moment *how* it takes place, *what* takes place is that a divided nerve suffers a traumatic degeneration for a short distance in the cut ends of both its proximal and distal segments. There is a slight difference in the two segments in this traumatic degeneration owing to the fact that the proximal segment is in direct communication with the so called trophic influences emanating from the central station, and, as a consequence, its wires or axons—or

whatever you choose to call them—do not degenerate except for a short distance proximal to the place in the nerve trunk where the trauma has occurred.

The proximal axons multiply and try to push on out into the distal space hoping to make some connections, and do some work again. Many of these, failing to make connections turn back—get "balled up" so to speak hence the so called bulbous end of the proximal segment.

Now the distal segment undergoes a similar traumatic degeneration of the cut end which is necrotic in character, but, having no connection any longer with the central trophic influences it makes no effort to function there is no multiplication of axons no bulbous end. In addition to this traumatic degeneration it undergoes another form of degeneration throughout its whole extent right down to the terminal end plates, which transmit the nervous force to the muscle fibers.

This is called wallerian degeneration. What is wallerian degeneration? It is a very definite complicated process which begins at once in the distal segment of a nerve when it is cut off from its central station at any point. This may take place by a squeeze from toxic poisoning or inflammatory swelling as in Bell's palsy or by actual division as in accidental trauma. When this happens, every last nerve cell in every axon disintegrates and finally disappears leaving a system of tracts or tubes called bands of Büengner.

Now the question of how this takes place has caused a great deal of strife and difference of opinion. Volumes have been written about it. Suffice it to say that "digestive ferments," enzymes, chemical or electrical influences, bring about a granular and fatty degeneration resulting in a mass of detritus in these tubes which, by invasion of phagocytes from the blood stream is taken up and removed, finally leaving the cleared out tubes. These tubes then contain no nervous elements capable of transmitting nerve impulses. They are past that possibility when response to faradic stimulation ceases. In time these pathways are completely vacated and made ready to receive new axons from the proximal segment if they are permitted to enter.

What's to prevent them? Pus, fat, muscle, toxic products, foreign bodies leucocytes, lymph in the scar. Do any of these impediments succeed in stopping all axons? Certainly not! Usually a few get by every obstacle but not in sufficient numbers to bring back muscular function.

When free passage is provided they "shoot through" with incredible speed and eventually many of them form connections with the terminal end plates in the muscle fibers.

The degenerative process in the distal segment goes on for several weeks. The main part of it however is accomplished in 2 or 3 weeks. There is a time when the remaining products of degeneration in the distal segment are supposed to have a "chemotactic action"—a "come hither"—an "attraction" for the axons of the proximal segment. They are supposed to orient them to exert a *ris a fronte* from the distal segment aiding the *ris a tergo* from the proximal segment. This chemotactic influence is supposed to be at its best about the end of the second week.

This observation was made by Ottorino Rossi who published an account of some clinical work he had done in Man quoted by Cajal where he says (8) the ideal graft is the peripheral stump with bands of Buengner, newly taken from the animal operated on, 8 to 15 days after the operation. The newly formed fibers travel through it with an extraordinary speed deviations and retrogressions being very much diminished. In order of effectiveness there then follow grafts of fresh nerves without bands of Buengner, and finally normal nerve segments which are preserved in a physiological salt solution under aseptic conditions' (Tello).

However the larger the animal and the larger and older the nerve the longer the degenerative process takes. My own experiments on rhesus monkeys lead me to think that it takes about 3 weeks to clear the tracts sufficiently for the best clinical results.

At any rate, this process of clearing out of the tubes in the distal segment of a divided nerve takes place through the combination of chemical and circulatory influences very actively for a period of from 2 to 4 weeks, and continues less actively for a much longer

time. And here one finds the answer to my questions about grafts.

When a nerve is divided and immediately reunited there follows a period of "hesitation" before recovery begins to be manifest, because this wallerian degeneration in the distal segment must take place and the paths be at least partially cleared before the new axons from the proximal segment can travel through. A fresh graft excised from another nerve is crowded with nerve cells which must "degenerate" and be cleared out in the same manner before new axons can pass through. This process when the nerve graft is immediately transplanted, must be accomplished with the handicap of no circulatory apparatus at first and only a poor one for some time. The graft must live on the fluids in which it is bathed and which are exuded from surrounding tissues, until it finally develops a circulatory system of its own.

In the meantime the whole distal segment with its undisturbed circulation has gone through wallerian degeneration rapidly. Then, when the transplanted graft is finally cleared out sufficiently so that the axons from the proximal segment no longer impeded have pushed on through it they are "received with open arms" at least with open tubes by the distal segment. Hence the long delay while the graft is being traversed, finally followed by signs of slight improvement as some axons reach their terminal connections, and then "tumultuous" improvement as hundreds of others do the same.

Then, why will not cutting the nerve selected for graft material and allowing the distal segment to degenerate for the proper time in its own environment with its undisturbed circulatory apparatus—just as happens in the distal segment of the facial—clear out the tubes and render a graft which has been excised from it almost equal to the degenerated distal segment of the facial as a conveyor of axons?

I have tried the plan on a number of rhesus monkeys and it works. I have "prepared" the anterior femoral cutaneous and the great auricular in this way. Degeneration has been allowed to take place for from 10 to 35 days. The protocol of the experiments follows.

PROTOCOL OF THE EXPERIMENTS

Antoplastic nerve grafts—"prepared by degeneration *in situ*"

Controls—fresh grafts

1. The anterior femoral cutaneous nerve

Single strand

- Experiment 3—rhombus No. 8
- Experiment 5—rhombus No. 6
- Experiment 7—rhombus No. 7

Double strand

- Experiment—rhombus No. 10
- Experiment 2—rhombus No. 8
- Experiment 4—rhombus No. 9
- Experiment 6—rhombus No. 14

Two strands

- Experiment 6—rhombus No. 6

The great auricular nerve

Single strand

- Experiment 9—rhombus No. 13
- Experiment 11—rhombus No. 14
- Experiment 2—rhombus No. 25

Three strands

- Experiment 9—rhombus No. 13
- Experiment 3—rhombus No. 26

Control

1. Experiment
2. Experiment 9

Antoplastic nerve grafts. The nerves employed in these experiments were (1) the anterior femoral cutaneous nerve and (2) the great auricular nerve.

A Control. A graft, freshly excised from another nerve was immediately placed in the gap between the proximal and distal segments of a divided facial nerve. Varying lengths of gap determined by removal of segments of varying measured lengths of the facial nerve.

A Graft from the distal segment of a similar nerve which had been previously "prepared." By "preparation" we mean that the nerve was divided. The distal segment was then left, undisturbed by dissection, in its own bed, for varying periods while it underwent wallerian degeneration, in exactly the same manner in which the distal segment of a facial nerve degenerates after division or injury.

These grafts, used as paths to convey axons from the proximal to the distal segment of the divided facial nerve are taken from nerves which have undergone varying periods of degeneration to determine if possible at what stage of this degeneration they will prove most attractive to the axons, or at least, present the minimum obstruction to their *en masse* passage.

Note.—In series of rhombus muscles the function of the facial nerve was ascertained either by division, resection, or section of alcohol within the rhombi, thereby causing transients facial palsy as evidenced by loss of all voluntary emotional, or reflex action. The distal segment was stimulated with the faradic current, at 100 to 2000 volts, to determine when muscular responses disappeared. (Wallerian reaction of degeneration.) In 8 it disappeared in 24 hours, in 1, it disappeared in 40 to 72 hours, in 11 it disappeared in 96 hours. In response period 9 days.

Experiment 2—rhombus No. 9, control.

45 hours. Complete loss of response in muscles of face to faradic stimulation. A double strand of the anterior femoral cutaneous nerve, 3 millimeters, inserted in gap.

44th day. Farist response to strong faradic stimulation in muscles of upper lip.

45th day. Farist response to strong faradic current in upper and lower lips.

46th day. Farist response in nose and lips.

70th day. Facial tic in muscles around the mouth greatly aggravated by faradic stimulation or conjunctival irritation. Winking reflex on threat and conjunctival irritation.

77th day. Tic very evident, no voluntary movements.

80th day. Response in muscles of lips to weak faradic current. Farist response in all muscles of face to strong faradic current.

95th day. Facial tic marked when animal is tied to table, violent on conjunctival irritation or faradic stimulation.

Note.—Difficult to differentiate between response to faradic stimulation and tic, as animal makes some responses when stirred up by stimulation on normal side.

124th day. Facial tic still marked. Response to strong faradic current in all muscles.

The tic is interesting in connection with the series of immediate grafts and various anastomoses recounted by Sir Charles Ballance and myself in our experiments reported in 1931 (Arch. Otolaryngol. 1932 Jan.).

Experiment 2—rhombus No. 2.

96 hours. Complete loss of response to faradic stimulation in muscles of the face. A double strand of the anterior femoral cutaneous nerve was prepared 10 days, 15 millimeters, and inserted in the gap.

120th day. Farist response to strong faradic stimulation in the muscles of upper and lower lips. Tests at 2-day intervals showed only weak response in the same muscles up to the 43rd day.

43rd day. Distinctly better response in all the muscles around nose and mouth. Farist response around eye.

40th day. Distinct improvement evident in all muscles.

55th day. Active response to weak faradic stimulation in all muscles.

57th day. Still improving: conjunctival reflex and threat reflex present.

61st day. Shows quick response in all muscles—voluntary and emotional responses very evident.

78th day. Very marked progressive improvement.

Experiment 5—rhombus No. 8.

45 hours. Complete loss of response to faradic stimulation in muscles of the face. A single strand of the anterior femoral cutaneous nerve, prepared 10 days, 7 millimeters, was inserted in the gap.

17th day. Weak response to strong faradic stimulation in the muscles of upper and lower lips and nose. Stimulation at 2 day intervals showed no definite change until

34th day. Definite response to strong faradic stimulation in all muscles of face.

44th day. Response to weak current around mouth, and to strong current in all other muscles.

55th day. Response to weak current in all muscles: conjunctival and threat reflexes to eye muscles; spontaneous movements.

73rd day. Marked progressive improvement.

87th day. Active conjunctival and threat reflexes. Farist response to weak current in all muscles. Facial tic in lower muscles of face: observed when animal is agitated and greatly aggravated by conjunctival irritation and faradic stimulation.

116th day. Facial tic still present. Response to weak faradic current improved in all muscles.

Experiment 4—rhombus No. 9.

48 hours. Complete loss of response in muscles of face to faradic stimulation. A double strand of the anterior femoral cutaneous nerve prepared 11 days, 10 millimeters, was inserted in the gap.

14th day Faint response to strong faradic stimulation in muscles of upper lip and nose.

30th day Definite response to strong current in all muscles, conjunctival and throat reflexes in eye spontaneous movements.

32nd day Unfortunately the animal died from the anesthetic. It was the most promising case in this series.

Experiment 5—rhesus No. 11

65 hours. Complete loss of response in muscles of face to faradic stimulation. Single strand of anterior femoral cutaneous nerve prepared 10 days, 6 millimeters, inserted in gap.

30th day Faint response to strong faradic stimulation in muscles of upper and lower lips. Tests at 48 hour intervals for following 16 days showed no definite change.

43rd day Response to weak current in muscles around mouth and nose, to strong faradic current in muscles of face.

57th day Conjunctival and throat reflexes in eye spontaneous movements.

62nd day Marked improvement in all muscles of face.

68th day Progressive improvement.

76th day Fair response to weak faradic current in all muscles. Active conjunctival reflex. Facial tic in lower muscles of face.

90th day Associated tic still marked on conjunctival irritation or faradic stimulation. Good response to strong faradic current.

111th day Tic appears less evident. Muscular responses to faradic stimulation decidedly improved.

Experiment 6—rhesus No. 16

68 hours. Complete loss of response in muscles of face to faradic stimulation. Two strands anterior femoral cutaneous nerve, prepared 14 days, 7 millimeters each, were inserted in the gaps first to auriculotemporal which had been accidentally divided second to main branch.

30th day Faint response to strong faradic stimulation in muscles of upper and lower lips.

38th day Distinct response in all muscles of face to strong faradic stimulation.

45th day No marked change.

70th day Distinct response in muscles of upper and lower lips to weak faradic stimulation. Response in all muscles of face to strong faradic stimulation.

81st day Conjunctival and throat reflexes in eye muscles. Facial tic in lower muscles of face—exaggerated by conjunctival irritation or faradic stimulation. Response in all muscles of face to weak faradic current.

87th day Tic not as regular or as strong. All muscular responses rapidly improving.

Experiment 7—rhesus No. 17

73 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the anterior femoral cutaneous nerve, prepared 21 days, 12 millimeters was inserted in the gap.

30th day Faint response to strong faradic stimulation in upper and lower lips.

37th day Faint response to strong faradic stimulation in muscles of upper and lower lips, and around nose.

51st day Response in all muscles of face to strong faradic current.

65th day Conjunctival and throat reflexes present. Facial tic appeared in lower muscles of face. Response in all muscles of face to weak faradic current.

73rd day Conjunctival reflex active. Facial tic exaggerated by throat, irritation of conjunctiva, or faradic stimulation. All muscular responses were improving.

79th day Facial tic not as regular or as strong. Muscular response to faradic stimulation improving rapidly.

Experiment 8—rhesus No. 18.

218 hours—0 days, 2 hours. Complete loss of response in facial muscles to faradic stimulation. A double strand of the anterior femoral cutaneous nerve, prepared 35 days 8 millimeters, was inserted in the gap.

16th day Faint response to strong faradic stimulation in all muscles. Weak conjunctival reflex no throat reflex.

23rd day No marked change.

51st day Conjunctival reflex incomplete. Response in all muscles to strong faradic current improved. Weak faradic current causes response in muscles of upper and lower lips and nose.

59th day Active conjunctival reflex. Facial tic in lower muscles of face. Response in all muscles of face to weak faradic current. Stimulation and conjunctival irritation exaggerate facial tic.

65th day Facial tic decidedly less evident. Fair response in muscles of face to weak faradic current.

Experiment 9—rhesus No. 12. Control

45 hours. Complete loss of response in muscles of face to faradic stimulation. Three strands of the great auricular nerve, 5 millimeters, was inserted in the gap. Stimulation with faradic current at short intervals gave no response in muscles of face until the fifty first day following repair.

51st day Weak response in all muscles to strong faradic stimulation. Faint conjunctival and throat reflex. A definite tic of the risorius at irregular intervals varying from a few seconds to a minute. The tic is exaggerated by faradic stimulation or conjunctival irritation.

64th day Faradic response much more definite the tic is still present.

70th day Conditions same as on sixty-fourth day.

91st day Faint response in all muscles of the face to strong faradic stimulation. Tic is so aggravated by stimulation that it is difficult to differentiate response to faradic stimulation from tic. Good conjunctival and throat reflexes.

119th day Facial tic continues *pari passu* with improving muscular responses. Response to faradic stimulation improving.

Experiment 10—rhesus No. 13

48 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 10 days, 6 millimeters, was inserted in the gap.

48th day Faint response to strong faradic stimulation in muscles of upper and lower lips.

54th day Definite response to strong faradic stimulation in all face muscles. Conjunctival and throat reflexes.

61st day Definite tic in the risorius aggravated by faradic stimulation or conjunctival irritation.

67th day Same reactions.

81st day Facial tic increases when animal is restrained, also exaggerated by faradic stimulation or conjunctival irritation. Active conjunctival reflex. Voluntary movements. Excellent response in all muscles of face to strong faradic stimulation.

93rd day Facial tic still marked. Fine response in all muscles of face to weak faradic stimulation.

109th day Facial tic not so marked. All muscular responses steadily improving.

Experiment 11—rhesus No. 14.

47 hours. Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 11 days, 7 millimeters, was inserted in the gap.

38th day Faint response to strong faradic stimulation in upper and lower lips.

41st day Response also in muscles of nose.
58th day Response to strong faradic stimulation in all muscles of face: a definite tic in the risorius, conjunctival and throat reflexes. The exaggerated by faradic stimulation and conjunctival irritation.

69th day All responses more definite: tic remains.

75th day Vigorous response in all muscles of the face to strong faradic stimulation. Tic aggravated by restraint.

107th day Fine response in all muscles of face to weak faradic stimulation. Tic remains but seems less regular.

Experiment 12—rhombus No. 25.

7 hours Complete loss of response in muscles of face to faradic stimulation. A single strand of the great auricular nerve, prepared 21 days, 8 millimeters, was inserted in the gap.

17th day Faint response to strong faradic stimulation in muscles of upper and lower lips.

26th day Response to weak faradic stimulation in muscles of upper and lower lips. Response to strong faradic stimulation in all muscles of face.

33rd day Responses in all muscles improving.

61st day Fair response in all muscles of face to weak faradic stimulation.

Experiment 13—rhombus No. 26.

96 hours Complete loss of response in muscles of face to faradic stimulation. Three strands of the great auricular nerve, prepared 2 days, 7 millimeters, were inserted respectively in gaps as follows: (a) from the proximal segment to the temporal branch, (b) from the proximal segment to the cervicofacial branch, (c) from the proximal segment to the buccinator branch.

16th day Fair response to strong faradic stimulation in muscles of upper and lower lips.

25th day Slight response to weak faradic stimulation in muscles of upper and lower lips. Response in the risorius to strong faradic stimulation.

32nd day Definite response in all muscles to strong faradic stimulation.

54th day Tests made at short intervals showing responses to faradic stimulation improving.

60th day Conjunctival and throat reflexes present. Facial tic appeared in lower muscles of face. Aggravated by conjunctival irritation and faradic stimulation. Muscular responses to weak faradic stimulation in all muscles of face.

You will notice, on reading the protocol, that the muscular responses where the "prepared" grafts were used were obtained in a quarter to half the length of time required to obtain similar responses in the controls, where fresh grafts were used.

It would seem, from a study of these experiments so far as they have gone that when autoplasmic nerve grafts are employed to bridge gaps in a divided facial nerve better results—both as to speed of recovery and more nearly normal restoration of function—may be expected if the graft material is "prepared" by division and degeneration of the nerve *in situ*.

It is safe to say that any graft which has been taken from a nerve "prepared" from 2 to 4 weeks will probably be much more efficacious than a fresh graft. While any desired nerve may be so "prepared" and employed I believe that the anterior femoral cutaneous is the best.

I have as yet used only fresh grafts in ten humans. I am now "preparing" the anterior femoral cutaneous which I propose to use, after 3 weeks' degeneration, in 2 cases of accidental palsies following mastoid operation, 1 of 4 years' duration and the other of 4 months' duration.

I believe that direct repair by transplantation of autoplasmic grafts either freshly excised or prepared as I have indicated will supplant the method of anastomosis in all except the rare cases in which the facial palsy has been caused by intracranial injury or disease.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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FEBRUARY 1933

THE 1932 CLINICAL CONGRESS IN ST. LOUIS

THE twenty second annual Clinical Congress of the American College of Surgeons held in St. Louis October 17-21 1932—the first Clinical Congress held in that city—will be remembered as an outstanding success by reason of the large attendance, the widespread enthusiasm, a clinical program of exceptional merit and broad scope and a series of scientific meetings and conferences that brought to the attention of the profession many notable contributions. A highly interesting program of operative clinics and demonstrations in thirty hospitals and two medical schools that embraced all phases of general and special surgery organized by the Committee on Arrangements under the leadership of Dr. Everts A. Graham chairman was presented during the five-day session and received enthusiastically by the 2,000 visiting surgeons.

In the departments of ophthalmological and otolaryngological surgery special plans for the entertainment of the visiting surgeons resulted in a comprehensive clinical program emphasizing the important research work being done in

St. Louis institutions. At two evening sessions eminent specialists in these fields presented important and timely papers to large and appreciative audiences.

Four symposia presented at the afternoon sessions were outstanding features of the Congress and provided a number of notable contributions to our surgical knowledge. These symposia included (1) "Cancer is Curable" with reports on five year cures of different types of cancer by thirty eminent specialists in the various surgical fields, (2) "Treatment of Fractures" participated in by a group of surgeons of wide experience in this special field, (3) "Industrial Medicine and Traumatic Surgery" with papers and discussions dealing with the clinical and economic aspects of this important field and a report of last year's survey of American industries by representatives of the College, (4) "Teaching of Surgery and the Surgical Specialties" which included a discussion of methods recommended for graduate and undergraduate instruction. The papers presented appear in this issue.

The program for the evening meetings planned for audiences of varied interests, presented a group of papers of exceptional worth contributed by men of high standing in various fields of surgery. They attracted large audiences that crowded the ballroom to capacity. At the presidential meeting on Monday evening the retiring president Dr. Allen B. Kanavel of Chicago, in speaking on the "Intangibles in Surgery" found in the philosophy and history of surgery the proper foundation on which to build for higher ideals. Dr. J. Bentley Squier, of New York, inaugurated as president, delivered an address dealing

definitely with the Fundamentals of Specialism. Sir William I DeCourcy Wheeler of Dublin, Ireland past president of the Royal College of Surgeons of Ireland presented for the John B Murphy oration in surgery an interesting talk on Pillars of Surgery

A symposium on thoracic surgery another on intestinal surgery together with a group of papers dealing with other surgical and gynecological subjects were interesting features of the meetings on Tuesday Wednesday and Thursday evenings. The papers, by speakers from outside St. Louis with wide experience in their special fields were short and well presented with the use of many illustrations. These were discussed by local clinicians. In all of these the clinical aspects were especially emphasized bringing to the members of the Congress many new ideas and added inspiration. The papers are published in this issue

The beautiful ceremonial of the Convocation on Friday evening attracted an audience that filled the ballroom of the Jefferson Hotel to overflowing. A class of 633 new Fellows, coming from forty three states two provinces of Canada, and six foreign countries were admitted into fellowship in the College. Honorary fellowships were bestowed on two distinguished visitors Sir George Lenthal Cheate London England and Dr José Goyanes, professor of surgery in the National Academy of Medicine of Madrid, Spain.

In his presidential address, Dr Squier reviewed in detail the accomplishments of the College during twenty years and contributed suggestions as to its future activities. The fellowship address by Professor Robert A. Millikan director of the Norman Bridge Laboratory of Physics, California Institute of Technology gave a highly interesting presentation of Some New Things in Physics.

An audience of 10,000 attended the Community Health Meeting on Wednesday eve-

ning crowding to its limit the gymnasium of St. Louis University and overflowing into and filling to capacity the auditorium of the law school of the same university. It was estimated that in addition 10,000 people were turned away unable to gain admittance to either of these halls. Twelve speakers presented to this vast audience the aims and objects of the American College of Surgeons told of the contribution of scientific medicine to the progress of the civilized world described modern hospitals spoke of specific diseases and their symptoms, such as cancer appendicitis backache nervousness, etc. These vast audiences evidenced the avidity on the part of the public for reliable information on matters pertaining to personal health—ample justification for the continuance of the College's educational program under which community health meetings have been held in 111 cities of the United States and Canada since 1920. As a part of the program health talks were given in St. Louis by speakers for the College to the students of ten high schools, members of twelve clubs and a vast invisible audience through fifty-seven radio broadcasts.

The annual hospital standardization conference, with a four-day program presented many valuable discussions of vital problems concerning administrative and professional matters with emphasis on hospital economics. A unique feature was carried out on the closing day—the presentation in two hospitals of a series of practical demonstrations in hospital administration. A summary of the results of the conference would include (1) A better appreciation of standardization principles and their practical application, (2) a clearer understanding of the hospital's internal and external relations (3) a further contribution to our knowledge of the application of business methods as a means of meeting present day economic problems.

A well organized and adequately manned press bureau worked in close co-operation with the local newspapers and the great international press associations to provide an adequate report of the proceedings of the Congress. Recognizing the importance of such a gathering and the opportunity for the dissemination of news of important advancements in medical science, out of town newspapers sent special representatives. The result was that the press of the country at large carried each day comprehensive and well written articles that reflected credit upon the College and its accomplishments.

CONFERENCE ON CURABILITY OF CANCER

WHEN thirty of the eminent surgical specialists of the country assembled and tell of their cases of cancer that have lived five years and more following treatment, the total of their successes assumes a proportion that must give renewed stimulus and confidence to the surgeon justification for increased hope on the part of the patient with cancer decision to apply for early treatment when cancer is suspected, and a brighter general outlook for the future in the cancer field.

The conference on the Curability of Cancer held during the 1932 Clinical Congress of the American College of Surgeons must perform produce such results. Surely the more than thirty thousand added years of health represented by the reports (of their own cases) given by these surgeons must command the attention of one attempting to appraise the value of the work of the medical profession. This is no exaggeration, for the average duration of life in untreated cancer cases is usually estimated at two and one half years, and the four thousand three hundred forty four patients reported by these sur-

geons are known to have lived in good health from five to thirty years following treatment.

Some of the speakers at this conference presented good and valid reasons why the interest of the medical profession in the advanced cases of cancer should be increased. Occasional unexpected responses to therapy and the relief that can be afforded to the majority of these patients by surgical radiological, or medical palliative measures urgently bespeak an active and confident attitude on the part of the medical profession toward the late cases of cancer.

While it is well known that cancer on the superficial parts of the body as a rule is recognized at an earlier stage and therefore gives better statistical results, in a survey of the program of this meeting the attention is captivated by its inclusiveness which demonstrates the successful application of therapeutic methods even to those parts of the body which are the most difficult to approach.

Another interesting phase of this conference was its forceful refutation of the alleged soullessness of the modern clinic. The introduction of accurate records, and of complete follow up data, which are made possible by the utilization of social service workers, has made it possible for the surgeon to maintain close supervision of his patient and to know the condition of that patient over periods up to thirty years.

It is hoped that one result of this conference will be the stimulus offered to the medical profession to make use of the methods of diagnosis and treatment which have been shown to be successful, and by earlier and more effective application of these methods, to other cancer cases to increase manifold the number of cures of this disease.

ROBERT B. GREENOUGH
BOWMAN C. CROWELL.

PRESIDENTIAL MEETING, CONVOCATION

ADDRESS OF WELCOME¹

EVARTS A. GRAHAM M.D., F.A.C.S., St. Louis, Missouri

ST LOUIS is pleased to welcome the Clinical Congress of the American College of Surgeons. We hope that this first visit to this city will prove interesting and pleasant enough to warrant a return. To many of our eastern friends the Mississippi River still marks the edge of the frontier as it did at the time that Lewis and Clark started from here on their famous expedition to explore the Northwest Territory. We hope however that after the week of medical activities no one will feel that St. Louis is still a frontier town in a medical sense despite its location on the western side of the Father of Waters. The two medical schools and the many fine hospitals feel that they can be justly proud of their accomplishments. St. Louis was one of the first cities of the country to develop modern university medical education and the standards and methods estab-

lished here have served as models to many of the more recent extensive educational developments in other parts of this country and to some extent in other countries. Although the realization of our plans has not been completed—in fact no scheme of education can ever properly be considered completed—we invite you to join with the group of visitors from all parts of the world interested in medical education who have come here to investigate at first hand what we are attempting to accomplish. St. Louis is said to be a city surrounded by the United States. It is not Eastern, Western, Northern, or Southern. It has perhaps some of the attributes of all sections of the country. We like to think that from the South we have taken over the characteristic feature of hospitality and I hope that this good side of us will be in evidence this week.

¹Presented before the Clinical Congress of the American College of Surgeons, St. Louis, Missouri, October 7-12, 1933.

INTANGIBLES IN SURGERY¹

ALLEN B. KANAUEL, M.D. F.A.C.S., CHICAGO

IN our commendable endeavor as an organization to elevate the practice of surgery we may well pause to consider if in our emphasis upon technical training, standardization of teaching and practice, and study of economic factors in medicine, we are not overshadowing the intangible qualities that have made surgery a growing science and an increasing art. An organism may be perfect anatomically but it needs the elusive spark of life to give it being. Ideals, self-sacrifice, personal and professional honesty, love of the search for knowledge, culture, judgment, common sense, and imagination may not be ponderable but nevertheless their presence marks difference between technical efficiency and greatness.

In this day of commercialism, political crassness, and Freudian complexes, the ideals and as-

pirations of the physician and scientist come as a breath of fresh air in a musty room. The commercial world exalts those who accumulate wealth; the political deifies the narrow minded nationalist and the unthinking citizen finds his hero in the banalities of the moving picture theater. Medicine engrossed in scientific investigation and its application to the relief of human suffering reserves its insignia of greatness for those who find their satisfaction in service and in the search for the elusive secrets that benefit mankind.

The American College of Surgeons was founded upon the ideal of disinterested service. The permanent accomplishments of the College depend upon the measure of devotion of each fellow to this basic principle. This ideal is a part of our heritage. Guy de Chauliac, the father of surgery

Address of the Elected President, presented before the Clinical Congress of the American College of Surgeons, St. Louis, October 17, 1933.

said the surgeon should be "modest, dignified, gentle and merciful, not covetous nor an extortionist of money, rather let his rewards be according to his work, to the means of the patient to the quality of the issue and his own dignity." Paracelsus, two centuries later, said that the "physician shall study daily and learn from the experience of others. He shall at all times be temperate, serious, chaste, living rightly, and not a boaster. He shall consider the necessity of the sick rather than his own, his art rather than his fee."

The unthinking public, accepting its opinions ready made from the tabloid newspaper, the smoking compartment of the Pullman, and tea-cup gossip, presumes to judge the qualifications and standing of the physician. The clever carpenter in surgery, the facile adaptor of diagnostic principles, and the self-confident therapist may attain an ephemeral eminence but the calm, flowing and relentless stream of time leaves standing only our Pasteurs, Listers, and Hunters—our idealists, imbued with self-sacrifice, honesty, industry, learning and gifted with judgment and imagination. The men we honor go their way with equal happiness in daylight and darkness, sacrifice comfort, home, and even life itself in their devotion to their chosen calling. Mawkish sentimentalists bewail the laboratory use of animals that has saved tens of thousands of human lives but forget that the physician has been just as willing to use his own body as a human test tube or culture medium, that Senn transplanted to his own body cancer cells to disprove their transmissibility, that Lazzar by the loss of his life demonstrated the cause of yellow fever and that Ricketts by a similar sacrifice proved the source of typhus fever.

Incorruptible honesty in scientific investigation and in our relations to patients and the community must be the foundation of our work. No surgeon can be truly great if he deceives himself or the public. He should never administer treatment except after painstaking study of the patient, his disease and his bodily resistance, and only after he is convinced that he would accept the same advice for himself or his family. He should not undertake surgical intervention unless he is competent to treat not alone the specific condition attacked but also any complications that may arise. Any operation performed at the request of colleagues without personal study and justification shows not only intellectual laziness, but culpable acquiescence. Those who would barter their inheritance of disinterested service for money or let it influence their judgment should

not forget that Judas thirty pieces of silver bought only a potter's field.

The little surgeon hastens to report his successful experiences; the great surgeon is more concerned with his failures. Sims reported twelve failures on a single patient before he discovered the principles of the treatment of vesicovaginal fistula. Fenger was as careful to publish the fact that the first six patients upon whom he performed hysterectomy died, as he was to present his great work on stones in the common bile duct. Mott did not fear to announce a fatality from his first attempt to ligate the innominate artery. These men had good precedent, however, for of the forty-two clinical cases reported by Hippocrates, sixty per cent had a fatal termination. "I have written this down deliberately," says Hippocrates, "believing it as valuable to learn of unsuccessful experiments and to know the cause of failure."

The great surgeon, in common with all scientists, loves to wrest from nature its secrets for the pure joy of increasing knowledge. He may be oblivious of its immediate application but he is confident of its ultimate benefit to mankind. Franklin's apt rejoinder, "what is the use of a baby," to a critic of pure scientific investigation is a complete answer to those who demand immediate results from such studies. Ramsey and Randleigh discovered invisible gases by using a microbalance that would detect a difference in weight of one-fourteen billionths of an ounce, and by substituting one of these for nitrogen helped to prevent the 'bends' in caisson workers. Dalton made two hundred thousand observations on the atmosphere and in studying the composition of air, arrived at the atomic theory. Resting on Dalton's assumption, Priestley obtained pure nitrous oxide and Davy discovered its physiological effects so beneficent in the practice of medicine. Insulin, adrenalin, toxins and anti-toxins, asepsis and antiseptics, all surgical and medical procedures, have back of them a dim but glorious procession of physicians and investigators who have devoted their lives to unraveling the tangle of nature. It is to these restless spirits of insatiable curiosity that medicine owes its debt, much more than to the facile adaptors of other men's ideas.

The physician must be industrious. He must submerge his life in his profession and the lives of his patients. Medicine is a jealous mistress. She brooks no rivalry with business, art, or social life. Gross wrote his great surgery while being driven about to make calls upon his patients. Ehrlich tried six hundred and five chemical combinations

before discovering salvarsan. The Curies searched through a ton of pitchblende to find a few crystals of radium. The great among us are driven by this dominating passion and are not content to whisper their *Vnus Dimittis*. Now let thy servant depart in peace, until they have added something of permanent value to the storehouse of surgical knowledge. This is not with the hope of immediate fame but with the laudable desire to be associated, even in a small way with the brilliant procession of physicians stretching back into dim antiquity who have enriched science and served humanity. Industry and knowledge beget modesty and few great surgeons could be psycho-analyzed as having a superiority complex.

A familiarity with the history of medicine and cultural literature is essential to the great surgeon. Hippocrates said: "An important phase of the practice of medicine is the ability to appraise its literature correctly." The trite expression "beacon lights of history" suggests the proper application of medical literature and history. It should warn us of the rocks and shoals to be avoided, indicate the clear channels of thought through which our course may be charted into the broad ocean of undiscovered knowledge where experiment, adventure into new waters of imagination may bring fruitful results. The mantle of Elijah does not fall upon the ignorant man. Culture safeguards our scientific studies, broadens our medical horizon, and gives joyous communion with the creative minds that have gone before. The surgeon cannot be truly great unless he loves literature, history and the cultural arts that stimulate, develop and enrich the inner man.

Narrow mindedness is the offspring of lack of culture and literary perspective. Productive experimentation is not blind chance but constructive hypothesis based upon knowledge. When Becher introduced the theory of phlogiston as an element of fire to explain burning, oxidation, and calcination—he retarded science for a century. It was theory without basic knowledge. Unfortunately we still repeat the same error in modern medicine. Our carpenter gastropexies, our short circuiting operations for gastropnoia advocated without physiological knowledge, and our abandoned drugs introduced by empirical rather than scientific methods, are not far enough from the bezoar stones, electrical belts, and the manipulations of the quack to save us from a measure of just criticism.

Judgment and common sense are inherent qualities, but they may be improved by thought and study. Infrequently we see too ready acceptance of theoretical procedures and advertised

nostrums, operations advocated without adequate analysis of the dangers and complications, and surgical procedures instituted without due consideration of the resistance of the patient and the physiological result. The surgeon who rushes to introduce selective "free wheeling," "dual control," and the "high compression" motor into his practice is seldom the great leader of his profession. It is true that this ill advised haste more often arises from thoughtless enthusiasm than dishonesty, but it does show a lack of judgment. The use of new clinical procedures should be preceded by physiological study, their value verified by careful experimentation and their employment dictated by judgment and common sense. Our surgical highway is strewn with discredited diagnostic procedures, discarded anesthetics, and non-physiological operative procedures. We think of Pare as the imaginative surgeon but one has only to read the delightful description of his treatment of the compound infected fracture of the *Marquis d'Auret*, to realize that he was endowed with superlative judgment and common sense. In this day of futurists and cultists in medicine, as well as the arts, let us not forget that common sense is the basis of all good surgery.

Nothing vitiates judgment and common sense more than the tyranny of the fixed idea. The surgeon should not be a cinematographic automaton. Open-mindedness is probably the hardest quality to maintain. Several centuries ago Roger Bacon said the causes of human error were undue regard for authority, habit, prejudice, and the false conceit of knowledge. And Turgot, "It is not error that opposes the progress of truth. It is indolence, obstinacy, the spirit of routine and everything that favors inaction." The little surgeon with his fixed ideas institutes procedures cemented by authority or habit, cannot meet in a constructive way new or unexpected conditions, does his gastro-enterostomy for all ulcers of the stomach, uses the same anesthetic for all cases, treats his fractures by the same routine method always, does the "Smith" or "Jones" operation in a given condition without having the pliability of mind or imagination to modify it to meet the varying conditions. All science suffers from this blight. Lavoisier's head had already fallen from the guillotine before Priestley acknowledged the possible truth that burning was the union of the consumed substance with oxygen. Berzelius' classic contribution upon nitrous oxide was refused publication by the Academy of Science because "they did not approve the new chemical nomenclature" of Lavoisier which he had dared to use.

Our institutions of learning too often teach standardized courses, foster the groove mind and find it difficult to encourage the genius in special lines. Berzelius, the Swedish chemist, was warned on his graduation day that there was no hope that he would do anything creditable since he had cut his Hebrew courses. Liebig was expelled from school with the statement that he was "hopelessly useless," because an explosion occurred while he was devoting his time to some original experiments with fulminic acid and John Hunter was the despair of his parents and teachers because he preferred to study nature in the woods rather than from books.

Imagination is the quality that raises us above mediocrity. It is not the peculiar attribute of the educated man. The Melanesians, before the advent of Cook, used the freshly cut and peeled branch of a tree as an intramedullary splint in fractures. The plaster cast had its origin in the practices of the African savage. To imagination science owes its progress. Avogadro had no balance to weigh his molecule no microscope to see it, no chemical reaction to prove it. It was a pure fabrication of his brain but justified by the fact that it explained known facts and was the solid foundation for new conceptions. Mendeléeff's periodic table of elements and Moseley's X-ray spectroscopic prophesy and proof of ninety-two elements, were imaginative conceptions resulting from an almost fanatic devotion to intense investigation. Langmuir's conception of the structure of the atom may one day make real the alchemist's dream of transmitting lead into gold. The imaginative scientist assumes majestic stature in comparison with those who follow meekly the blazed paths of life.

The history of medicine is the history of imagination—first superstition then concepts evolved from known facts, and finally experimental,

laboratory, and clinical verification of theory. Paré's ligature, Lister's antiseptics, Morton's and Long's anesthesia, are but three of the thousands of milestones that mark the path of imagination that great physicians have trod. Pasteur has said "Without theory practice is but routine born of habit. Theory alone is able to call into being and develop the spirit of invention."

The American College of Surgeons is interested not alone in assuring competent care to the sick but also in advancing the frontiers of medical knowledge. In our intense study of the obvious and practical we should not neglect to emphasize that unselfish service, personal and professional honesty, the urge to seek new truths, industry, broad culture, judgment and imagination, even more than technical efficiency, are the qualities that have given American surgeons an enviable position in international surgery. It is these that inspired McDowell when he did his first ovariectomy, Post when he first tied the femoral artery for popliteal aneurysm, and Beaumont when he investigated the function of the stomach on Alexis St. Martin. It is these that made Dudley Mott, Brashear, Jameson, Wyman, and Sims trail markers in the surgery of the new world. It is these that brought fame to our Senns, Fengers, Murphys, to our Bulls, Warrens, Agnews, that inspired our Mayos, Criles and Martins.

Technical dexterity in surgery is but the vehicle for the translation of these intangible qualities into surgical eminence. Elusive though they may be, they alone lead to enduring fame.

I paraphrase for you this sentence of Renan's: "Fame is a great coquette. She will not be sought too passionately, but often is most responsive to indifference. She escapes when she seems to be caught, she surrenders if patiently waited for, showing herself after farewells have been taken but inexorable when loved too ardently."

FUNDAMENTALS OF SPECIALISM¹

J BENTLEY SQUIER, M.D., F.A.C.S., New York

IN earliest recorded history the physician was priest, magician and medicine man. As human intelligence advanced to higher levels he was forced to split up his activities and declare himself. Some became priests, some charlatans, and others medical men.

In Egypt, sixteen centuries before the advent of Christ, this had already happened. But in other parts of the world where intellectual processes were slower in unfolding it did not occur until many centuries later. When Herodotus made his much exploited journey he found medical men even then further concentrating their endeavors for there was a special physician for almost every disease. The so called overspecialization of modern medicine might therefore be considered a reversion to type possessing at least, a precedent in antiquity.

The passing of the "old time" practitioner has been made a subject of much lamentation and from a purely sentimental angle deservedly for embodying as he often did, the attributes of friend, priest and physician, he held a very personal relation to his patient and his virtues have been loudly extolled. The paucity of his scientific information was offset by a great breadth of character and a wealth of human understanding. These qualities will ever remain the most distinguishing signs of greatness in any physician of whatever period. We pride ourselves upon the prodigious developments of theoretical and applied science which the past fifty years have produced, but in the minds of many exists a grave doubt as to how greatly all of these have added to the total of human happiness.

Every new step on the path of knowledge had opened to our vision uncharted deserts of human ignorance. If the goal of scientific progress is the production of human happiness, we of today may become objects of severe criticism fifty years hence for not having better utilized the scientific discoveries of this generation. It behooves us then to acquire the old time doctor's human understanding, kindly disposition and humble attitude for these are fundamentals of our calling, and also in order to neutralize any criticism of our own shortcomings which in years to come is bound to be made.

It is still within the ken of the older generation when a specialist in medicine was looked upon askance—as if possessing mental obliquity. But

the passing of years has effaced that view and now specialization within medicine has become as necessary as specialization in every other branch of science or profession. In engineering there are chemical, civil, electrical, and mechanical engineers. In law there are those who devote themselves to banking, civil, corporate or criminal law and so forth.

For as the world has aged, knowledge has increased to such an extent that it is now beyond human intelligence for any one individual to learn in the short span of life but a part of the existing information concerning any science or profession. To attain proficiency necessitates concentration upon a limited field and any improvement brought to this end will be beneficial to all. Every outstanding advance in medicine has resulted from intensified effort on one problem, the solution to which has opened the way to further progress.

It is to be regretted that the thought still exists in the minds of many that when a physician becomes a specialist he at once lays claim to superior proficiency. Whereas, by limiting his work he is but making a laudable effort to acquire proficiency.

The division of physicians into two main groups, one interested in medicine the other in surgery has given rise to much misunderstanding. This grouping has developed from a difference in indicated therapy and not from a difference in medical thought. In the final analysis, surgery is but a therapeutic measure for the treatment of certain diseases, injuries, or the correction of deformities and so on. An expenditure of more time and effort is required to learn how skillfully to administer surgical therapy than to administer a dose of medicine, but to be able to determine which type of therapy should be used requires similar fundamental knowledge.

The surgical remedy however, frequently necessitates adding injury to the tissues of the body by wound production, thereby injecting a second healing problem. The surgeon must heal the patient of the wound as well as the disease. During the course of this wound healing many complications may develop which require extensive medical knowledge in order to treat them intelligently. The patient may succumb to the disease or to complications arising directly or indirectly from the administration of the surgical

¹Thursdays Address, presented before the Clinical Congress of the American College of Surgeons, St. Louis, Missouri, October 17-21, 1924.



Henry Lynn

remedy. The surgeon then has to share with disease the responsibility of death while in the purely medical care of the sick if one remedy fails others are forthcoming or if all fail the demise of the patient becomes an act of fate. Not so in surgery, for the psychology of people is such that in their minds the thought lingers that if another remedy had been used or another surgeon had been in charge the result might have been different. The reverse of this however is stimulating for when surgical therapy is successful in effecting a cure it becomes more a testimony to the personal excellence of the surgeon than to the therapy instituted for his service has been definite individualistic and in no manner speculative.

He will be judged absolutely upon the outcome of his own act and he must be in a position to justify it at every angle. A surgeon therefore, should possess not only the technical skill properly to administer the surgical remedy but should be capable also of recognizing the possible presence of coexistent pathological lesions in any patient. He should be able to evaluate the influence for or against surgical interference which added lesions may produce. If the surgeon has to rely upon the judgment of others for this knowledge, he has not the proper conception of his responsibility.

This is but further endorsement of the time worn adage—To be a good surgeon one must first become a good physician. A good surgeon must combine the qualities of both. Changing times will never vary the wisdom of this advice, but in the hurry of every day life to become producers, many disregard it in an effort to make a short cut to economic success. The attention of such individuals should be directed to the facts elicited by a survey of the earning capacity of the profession compiled by the American Medical Association. It brought out that the largest gross incomes are made by physicians who have spent ten or more years in preparation and the low gross incomes are among the physicians who have had three years or less of preparation.

The road to the attainment of excellence in any branch of medicine or surgery is the same long route. The student in starting to follow this route soon finds it a maze. He becomes confused by the chaos existing in undergraduate medical education. This chaos has been produced by the tremendous mass of new information which the past fifty years have brought to all branches of science. Men have been intellectually unequipped to make proper use of it. In an attempt to keep abreast of the rapid strides of modern medicine,

the faculties of medical schools have added new requirements and subjects to the curriculum to such an extent that it is almost impossible for the student to acquire during his undergraduate course more than a smattering knowledge concerning many of them. The Commission on Medical Education of the Association of American Medical Colleges has been trying since 1925 to arrive at a sensible solution of this increasingly difficult problem. That they will succeed is certain but in the meanwhile the student on his way to licentiate in medicine plods wearily on.

The overcrowded curriculum may, however, be of use if it produces in the student's mind a realization of the vast amount of mental exertion necessary to acquire a working knowledge of the science of medicine. For he must understand that he is not learning a trade and if he is to become learned in his profession will have to continue to study until the last of his working days.

It is my belief that before deciding to take up any one specialty in medicine or surgery, a recent graduate should be required to spend two years as an interne in the medical service of a hospital. If, during this period he can find time to study psychology he will never regret the extra effort, for all through his future professional life it will enable him better to understand a patient's viewpoint. It will also help him more easily to establish mental contact with a patient and thus more quickly gain the patient's confidence.

The reason for insistence upon preliminary medical internship is based upon many factors. An individual can never be sure that he will be able to fit into the specialty of medicine of his ambition. He may be unable to earn a living at it and be forced to select another.

Only about 15 per cent of patients require the services of specialists and it is wise for every physician to have had a preliminary hospital internship which gives broad medical training in order to readily adjust himself to unforeseen circumstances.

Having finished his medical service he is then ready for surgical training. If he elects general surgery two more years should be spent in the general surgical wards followed by a surgical fellowship of at least one year before being allowed to practice surgery. If he elects a surgical specialty he should devote at least one year to study in the general surgical wards and then two years in the wards of the elected specialty. This makes five years spent in hospital training and it may appear a lengthy apprenticeship prior to commencing practice, but better than curtailment, would be to reduce the time spent in acquiring

the academic requirements for admission to the undergraduate medical school. A student of medicine should be allowed to commence the study at an earlier age, so that he may still be in the impressionable years when his first contact with patients takes place. Place responsibility upon his shoulders early for it sooner makes him able to meet it.

The medical professions are now separated into groups variously devoted to experimental, research preventive teaching, and clinical medicine, hospital administration, public health service sociology etc. Medical service is being considered from a much wider angle. Society is insisting upon a more effective organization of medical service for the people as a whole rather than as individuals. This being the case, readjustments in medical education are unavoidable. Progress has created new responsibilities which fall not upon governments but on those who are masters of scientific method, the physicians themselves, and must be shouldered by them, if the profession is to retain its autonomy and independence. This situation has been only partly recognized by the profession even though considerable energy is being expended toward making opportunities for extension or graduate training for those desiring to enter any special group. Graduate education is the question of the hour and universities, hospitals, county medical societies, and academies of medicine are endeavoring to create and meet demand for it.

The necessity for a continuing education is, of course not new to the Fellows of this organization because an appreciation of this necessity actuated its formation. However with the increasing opportunities for graduate training, a conviction has arisen, both within and without the profession, that some means should be taken to compel those who practice as specialists to have had adequate training to warrant them in making use of such an appellation. This was most forcibly stated in the biennial survey of education made by Willard C. Rappleye for the Department of the Interior of the United States Government in 1928 and 1930. One of the concluding paragraphs of his report on medical education was as follows:

"The training of specialists is another phase of the larger problems of training personnel to meet the medical needs of the country. The time will come when the medical profession and the public authorities will devise ways and means of guaranteeing to the public that those who claim to be specialists are, in fact, competent by training and experience to perform the service they claim to be able to render."

This conviction is not limited to our country but is world wide, and certain European nations have made definite progress toward legalization of specialists. Although bills have been introduced in some of our States with a view to legalization of specialists, I believe it will be a sad commentary on the profession if further licensing by the government becomes necessary. There exists within this College the potentialities for the solution of this problem.

Universities are appreciating that definite courses for advanced study in medicine and surgery should be offered—leading to acquisition of special knowledge sufficient to justify a physician taking such courses to enter the practice of a specialty. Columbia University grants recognition for acceptable work in the clinical specialties by means of a degree of Master of Science. This degree does not designate to which special field of study the student has devoted himself. The requirements for the degree are broad in order to permit of flexibility in training for the various specialties. The requirements for admission to study for the degree are evidence of graduation from an approved medical school and the completion of an internship of not less than one year after graduation. The course extends over three years in the University or in hospitals recognized by it at least one year of which must be spent in the University. Intensive study in anatomy embryology physiology pathology bacteriology and in other fields of science is required as well as an active experience during the three year period of not less than eighteen months spent in the hospital, clinics, and diagnostic laboratories of the specialty elected. One university having initiated this others will join in supplying similar courses leading to a degree or otherwise.

The time is propitious and opportune for the American College of Surgeons to undertake another great work, which will become as far reaching in beneficial effect as that of standardization of hospitals. I would suggest, therefore, that from the already appointed committee on Graduate and Under-Graduate Teaching of Surgery and the Specialists the College Institute a forum for discussion of graduate medical educational problems. To this forum should be invited Fellows of the College who are teaching in institutions where graduate medicine is a part of the curriculum. Representation should also be requested from the Association of American Medical Colleges. By interchange of ideas, and using the University requirements leading to the degree of Master of Science as a basis for discussion, definite standards should be determined for

graduate training in every clinical surgical specialty. This training should be so comprehensive that there could be no shadow of doubt about a physician, who had been so trained, being able to qualify as a specialist in that branch of surgery in which he had majored. These standards of training having been formulated, ways should be devised to supply them, as well as means to have them made easily accessible to physicians in different localities. Supplying the courses of training should not present difficulties for on the roster of the Fellows of the American College of Surgeons are over ten thousand surgeons and surgical specialists and the teachers of surgery and its specialties in the Universities medical schools, and hospitals of the United States are with few exceptions Fellows of the College. Enlisting their aid and enthusiasm and by careful co-ordination similar courses technical and other experience could be made available in a multitude of centers. A merger of all approved agencies for graduate medical teaching in a labor of this kind, would effect a correlated educational program and would prevent the occurrence of chaos in graduate instruction which has been such a source of confusion in undergraduate training. The recent graduate from a medical school has a year or so of hospital internship but even then is without definite ideas as to how to fit himself for special practice.

The College having determined standards of training for special practice and having inspired making the acquisition of them accessible will be in a position properly to guide such an individual.

The College will become the supreme court for evaluating the excellence of the courses given in all centers of graduate training and its assump-

tion of this leadership will prove a most effective stimulus toward furthering graduate study in every branch of medicine or surgery.

There is one step further for the College to take—the most important step—and that step is making it imperative for every future member of the junior candidate group to acquire this fundamental training. For the sake of argument let us suppose that the requirements which the College has agreed upon are very comparable to the requirements for the degree of Master of Science. The junior candidate will have seven years before becoming eligible to Fellowship in which to acquire the knowledge and experience which by intensive study the Master of Science must acquire in three years. Many of the courses could be taken in different periods and in different institutions, and upon successful completion of any prescribed course a certificate would be given testifying to the fact by the institution in which the course was taken. When the candidate has received certificates of successful completion of all training requirements then upon submission of the one hundred acceptable case records at present demanded he is eligible for Fellowship.

For as in the ancient days the public forced the medical men to declare themselves as either priest, thaumaturge or medicine man so in the future will it become incumbent for physicians to declare which branch of medicine they are qualified by adequate training to practice with the added obligation of supplying a guarantee.

Let us make Fellowship in the American College of Surgeons the guarantee to the public that a physician possessing such Fellowship has received the proper fundamental training and experience to qualify as a specialist.

PRESENTATION OF HONORARY FELLOWS

FRANKLIN H. MARTIN M.D., F.A.C.S., CHICAGO

AT the Convocation on Friday evening Honorary Fellowships were conferred by the President on the following eminent surgeons

Sir George Lenthal Cheate London, England
Eminent Surgeon Knight Commander Order of the Bath
Commander Royal Victorian Order
Fellow Royal College of Surgeons, England
Walker Prizeman 1926-1931 Consulting Surgeon and Eminent Lecturer in Surgery Kings

College Hospital. Introduced by Dr C. Gordon Heyd.

Professor José Goyanes C. Madrid, Spain
Distinguished Doctor of Medicine and Surgery
Author and Philosopher, Professor of Surgery to the General Hospital of Madrid Founder and President of the Society of Surgery of Madrid
Member of the National Academy of Medicine
Doctor Honoris Causa of the University of Bordeaux. Introduced by Dr Rudolph Matas.

PRESENTATION OF CANDIDATES—CLASS OF 1932

FRANKLIN H. MARTIN M.D. F.A.C.S. CHICAGO

IN behalf of the Board of Regents of the American College of Surgeons, I have the honor to present for Fellowship in the College candidates as follows

United States	653
Canada	1
Alaska	1
Porto Rico	
Australia	1
Costa Rica	
Cuba	1
Korea	1
Peru	1
Republic of Panama	1
Total	655

Each year as we receive a new class of candidates into Fellowship, I am impressed by the prestige of an institution that can influence such a goodly number of busy practitioners of surgery to seek its portals.

To the casual observer these men and women appear as one more group that is being enrolled into our ranks. Complacently this observer shrugs his shoulders and reflects "How easy!"

As an illustration let us enumerate the following facts

There were 4,588 applications for Fellowship on file January 1, 1932. Seven hundred and seventeen of them were already approved by their State or Provincial Committees on Credentials. 1,786 were presented to State and Provincial Committees on Credentials during this year. Of these only 811 or 45.5 per cent, were approved and recommended for examination. Of the total recommended for Fellowship before and since January 1, 1932 (1,528) our careful sifting process has admitted to Fellowship only 633 or 41.3 per cent, constituting the candidates who are here present.

Surely if we pay tribute where tribute is due we must pay full portion to the magnificent group which is before us this evening. Veritably they are the survival of the fittest.

They are to be congratulated and the College is to be congratulated but above all we must congratulate the people who shall in the future seek their services.

Mr. President Inasmuch as the candidates herewith presented have fulfilled all of the requirements for admission and have affirmed the Fellowship Pledge of the American College of Surgeons on authority of the Board of Regents of the College I take great pleasure in presenting them for Fellowship.

CASE HISTORY HONOR LIST AND PRIZE AWARD

ALLEN B KANAVEL M D F.A.C.S Chicago

MEDICINE has progressed through the careful study of clinical symptoms and imaginative experiment. Hippocrates as far as we know was the first to make comprehensive reports of his clinical studies. One may today diagnose the pathological lesions of the ancient Egyptians by study of the reports of physicians recorded in the papyrus recovered from the tombs of the Pharaohs. Paré Potts Hunter Cooper Sydenham, and a host of others have engraved their names in the history of medicine through the careful analysis of symptoms and the adequate record of their clinical studies. SURGERY GYNECOLOGY AND OBSTETRICS was founded with the ideal of advancing the science of surgery by all practical means. The members of its Editorial Board are so heartily in sympathy with the program of the College and its demands that all patients should receive careful study as evidenced by adequate records that in 1930 they asked of the Board of Regents the privilege of presenting an annual prize in the form of a life Fellowship in the American College of Surgeons for the most acceptable set of case records presented by the candidates during the preceding year. The prize consists of five hundred dollars, invested in the name of the successful candidate for life dues in the American College of Surgeons and is accompanied by an appropriately engraved certificate of appreciation on behalf of the donor SURGERY GYNECOLOGY AND OBSTETRICS. The prize winner last year was Dr. H. H. Ogilvie, of San Antonio Texas.

In seeking the prize winner from among the successful candidates before you the committee has selected 45 sets of outstanding records. An analysis of the selected group discloses the fact

that they come from every part of the United States and one from Porto Rico. While New York, Boston, Chicago, New Orleans and St. Louis appear among the larger cities represented the greater proportion come from moderate sized or small cities throughout the country, thus demonstrating the widespread interest of the members of the College in careful case studies and records. From this group of 45 sets have been selected as being outstanding and the authors of these records have been placed upon an honor list. May I ask each honor man to rise as his name is read?

Charles B. Puestow, Chicago, Illinois
Reginald M. Norris, Jacksonville, Illinois
Leo M. Davidoff, New York, New York
William W. McGregor, Detroit, Michigan
Clyde H. Frederickson, Great Falls, Montana

And now, may I announce the prize winner from among this group and invite him to the platform to receive the certificate of appreciation from our official journal, and the formal receipt for life dues in the American College of Surgeons.

Will Dr. Frederickson please come to the platform?

Dr. Frederickson, this recognition of your work is an expression by the College of its belief that scientific investigation, careful records, and critical analysis of case histories elevates the standard of surgery and insures to patients the most efficient care. It is our hope that this expression of commendation may serve to stimulate others to emulate your example, advance the frontiers of surgical knowledge, and benefit those entrusted to our care. I congratulate you.

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meetings, Dr Franklin Martin became so impressed by the type of clinical teaching which was being given that it awakened in him a desire to place such teaching before all American surgeons. It was the right of a chance for the many to have opportunity comparable to that of the favored few. His creation of The Clinical Congress of Surgeons of North America was the first step toward the consummation of this desire. This society had its first meeting in 1910 and received the support of many noted surgeons and teachers of surgery.

However after the second meeting Dr Martin realized that the scope of this society was much too limited to encompass his more ambitious plans for improving American surgery. Such, doubtless, was his frame of mind when on a November day in 1912 he boarded the 20th Century train at Chicago. He was on his way to direct the third meeting of the Congress to be held in New York. As the train rushed on with the passing of each milestone, new ideas presented themselves and his ambitious plans assumed concrete form.

Calling the train stenographer he then and there dictated the ideals, the goals of ambition and the plan or organization for a society more comprehensive in its aims—The American College of Surgeons. When the train pulled into New York, to him the College was already a living thing.

Abraham Lincoln while on a train to Gettysburg to honor its hallowed ground wrote a short appeal for renewed consecration of the people's lives to the cause of freedom. His inspired words *ever remain a clarion call for devotion to democracy*.

Franklin Martin while on a train, in five short paragraphs had written a clarion call to American surgeons to consecrate their lives for devotion to surgical idealism.

On the last day of the Congress November 15, 1912 Dr Martin presented his resolutions for the foundation of the American College of Surgeons to over two thousand men who were attending the Clinical Congress. These resolutions read—there was silence—the audience pondered—could so small a group of surgeons influence and enlist a sufficient number of other surgeons to carry to successful conclusion such an ambitious undertaking?

Dr John B Murphy seconded Dr Martin's plan, and then Dr Edward Martin of Philadelphia, the president of the Congress made one of his eloquent incisive appeals for the establishment of the College but warned against any action which might give the impression to others

that the contemplated project was of vain glorious conception.

The resolution was passed by overwhelming endorsement.

A Committee of Organization of twelve was appointed and the names of those men insured success for the College from its very beginning. Their lives had been devoted to furthering surgical idealism and their integrity of character had won the full confidence of the profession as well as of the laity.

Those appointed to the Committee of Organization were

Edward Martin	Emmett Rixford
John B Murphy	Rudolph Matas
Albert J Ochsner	Charles H Mayo
Frederick J Cotton	George Emerson Brewer
John M T Finney	Walter W Chipman
George W Crile and	Franklin H. Martin

These names should be graven deep in the hearts of all Fellows of the College as they are graven deep in the hearts of those who have been so fortunate as to enjoy their friendships.

This committee in its work of organization was not hampered by tradition. Tradition was in the making. Ten days following ratification of the proposal for the establishment of the College, the Secretary of the State of Illinois on November 25, 1912, certified that the College was a legally organized corporation under the laws of that state. The first Convocation took place on the evening of November 13, 1913 at the Congress Hotel in Chicago. Dr John M T Finney was elected the first president of the College.

It was an encouraging incident at this first meeting to receive greeting and wishes for success from the Royal College of Surgeons of England. These were extended by its president, Sir Rickman J Godlee.

Honorary Fellowship in our College having been conferred upon him he then delivered the Fellowship address. In relating the motives which actuated the formation of the Royal College of Surgeons, Sir Rickman stressed that it was an attempt by British surgeons of over one hundred years ago finally to rid themselves of any remaining taint of the Barber's Guild of the Dark Ages or of the Company of Barber-Surgeons of the sixteenth and seventeenth centuries.

The academic atmosphere of the Royal College was of later development, and eventually it became the determining body for licensing British surgeons. The precise motives which initiated the formation of the Royal College of Surgeons

were quite dissimilar to those of the American College but the great desire to improve surgery was the ambition of both.

Nineteen years have passed since that first convocation. They have been years full of effort and mounting activities until now it is difficult to decide which have been most productive of result. The results obtained by the Committee on Hospital Standardization will perhaps always rank among its great achievements. The circumstance which brought about the formation of this committee and the decision to make a survey of the hospitals of the country are full of interest and I will devote a few remarks to their consideration.

The Founders of the College had not been subjected to examination as to their surgical capacity but by the time of the second convocation over two thousand applications for Fellowship had been received and the Regents appreciated that examination for admission to Fellowship must be instituted.

It was obvious that before admission, each applicant for Fellowship should possess an adequate background of surgical experience. Equally important however was for him to have strength of character to withstand absolutely every temptation to commercialize his calling. It was decided that a fair estimate of an applicant's surgical experience could be made by a careful examination of submitted case records of his personal work.

The estimation of his character must be left to his intimate associates, and for this the College would have to rely upon the judgment of his local confrères. A Central Committee on Credentials was appointed to pass upon the excellence of submitted records, with a local committee to pass upon the character and general fitness of any applicant. The examination of the submitted records, in many instances revealed a woeful lack of understanding of what really constituted a good case record, and many candidates reported that in the hospitals with which they were connected, no case records were even kept.

If this was the situation in many hospitals, what also were their surgical standards, what measures were being taken toward proper education of their internes, and divers other questions must be answered. To obtain this information an intimate survey of the hospitals of the country became imperative.

The Regents, however believed that such an investigation should be undertaken by the American Medical Association as it represented the medical profession as a whole.

Since 1910, the American Medical Association had been interested in classifying medical schools

and analyzing the results of examination of their graduates before state medical boards, and possibly on this account, were not interested in taking up another investigation at this time. Nevertheless the College determined to undertake the survey even though such an investigation presented many obstacles.

By what measures could the lay and medical boards of the hospitals of the country be induced to permit their institutions being investigated, classified, and standardized by the American College of Surgeons?

What presumption of a very young organization to consider that it was qualified to pass judgment on the efficiency of institutions possessing traditions of excellence which many of them held! To combat this opposition, the hospital authorities were informed that the contemplated investigations were instigated by a desire on the part of the College to be of valuable service to them to demonstrate how to make their hospitals of better service to the patients, to the community and a more advantageous workshop for their professional staff. To outline the standard of service they should demand of their medical staff, how to evaluate such service and the standard of ethics their staff should possess.

As this work progressed, those in charge were continually being consulted by heads of hospitals from all over the world as how to increase the efficiency of their institutions.

Today there is scarcely a hospital in our country whose personnel fails to be filled with pride to have their institution included in the ranking group of those which have been investigated. The initiation of this work required all the tact, patience and perseverance that the College could muster. The carrying on of the work to a successful issue took years of painstaking labor on the part of the officers of the College and those associated with them in this special undertaking.

If the American College of Surgeons in the twenty years since its incorporation had accomplished nothing else than the improvement which it has produced in raising the standard of American hospitals this work alone would have more than justified its birth.

Standardization of hospitals was commenced during the period when Dr. John G. Bowman was one of its officers. It was at this time that the Regents drafted the first tentative outline of the minimum standard for hospitals. Our Director General in commenting upon this outline in his report delivered at the annual meeting in 1924 said "This document has now achieved international fame and has become to hospital better

ment what the Sermon on the Mount is to a great religion.

Dr Bowman had exerted a unique influence on the College, for having had a scholastic and not a medical training, he viewed our problems in a more detached manner than could a man of medical mind. An idealist himself he appreciated idealism in others and was able to expound the doctrine of surgical idealism with inspiring conviction. Dr Bowman was called to become Chancellor of the University of Pittsburgh.

The standardization of hospitals was a project which required considerable expenditure of money, the raising of the endowment fund to meet this and the other increasing expenses of the College was a most creditable accomplishment in these early years. The Fellows at once responded to the call for funds, and by the time of the third convocation the sum of over two hundred and fifty thousand dollars had been pledged.

The fund has grown year by year until now it is well over one million dollars. It has been well invested and the income derived from it judiciously expended. The financial sagacity of those Fellows who have guarded this and all other funds of the College deserves commendation. An examination of the securities held by the College at this period of financial deflation produces admiration for the judgment of these men.

This spirit of the Fellows to give of their own without waiting for aid from philanthropical sources was the strongest demonstration of their belief in this institution. A similar spirit was exhibited, when it became expedient to determine which city—in the United States—should be chosen as the permanent home for the College. There was much discussion and the pros and cons make a long story. Finally it was decided as such questions usually are by the financial equation.

The Fellows of the College residing in Chicago and their friends raised the money purchased a site in Chicago, and gave it to the College. A few years later Chicago again made the College its debtor by presenting a building a monument to one of America's greatest surgeons, Dr John B. Murphy. There is a peculiarly significant sentiment in the principal College building being a memorial to him for you will recall that it was Dr Murphy who seconded Dr Martin's resolution for the foundation of the American College of Surgeons. It was to him Dr Martin had first confided his ambitious project, and it was from him that Dr Martin had received the most sympathetic encouragement.

Next year the College will meet in Chicago, and you Fellows will have opportunity to view its

home. If you start from Wabash Avenue and walk East on the north side of Erie street, you will pass first, the Administration Building of the College (a gift from Chicago Fellows), then the Murphy Memorial Hall (a gift from the family and admirers of Dr Murphy) and last, what is to be the greatest gift of all—54 East Erie Street and its contents—the Journal of Surgery, Gynecology and Obstetrics (to be a gift from Dr and Mrs. Franklin H. Martin). Pause a moment on the corner of Rush Street and consider how greatly the Journal has aided the College. Before the College was ever contemplated, this journal was already a publication of international importance. Later carrying our propaganda it helped us to win respect of the surgical world for the ideals of the American College of Surgeons.

The journal will become the most determining gift for success. The north side of Erie Street represents fulfillment. With this thought in mind cross to the south side and walk back. The first half of the block was bought by the College in 1928—and imagination visualizes a future building to house the library and museum, the second half of the block is now under consideration for developments in the future. The south side of Erie Street represents hopes deferred but long before another twenty years have elapsed these too will be fulfilled.

In 1916 the College activities became subservient to medical preparedness as war clouds were gathering and all efforts were extended to be in readiness if war was declared. The Secretary General of the College was appointed by our government to be the chairman of the Medical Board of the Council of National Defense. This appointment brought grave responsibilities to him and the manner in which he met them will ever be a source of great pride to this organization.

The Fellows responded nobly to the call for enlistment in the Reserve Corps of the Army and Navy. Dr Crile who was then president of the College had his Lakeside Hospital Unit mobilized in Philadelphia where the College met that year. It was an object lesson. When war was declared over 90 per cent of the Fellows were in uniform and those not in uniform were in some governmental service. However, what was true of the Fellows of the College was equally true of the whole medical profession of the United States. Never in history has the medical profession ever failed to respond to the call of duty. The World War brought our surgeons and medical men in close contact with those of our Allies. Working shoulder to shoulder with them under tragic circumstances produced mutual respect and regard.

Two episodes in the history of the College may bear retelling, even though many of you may be familiar with them.

The year following Sir Rickman Godlee's visit to the first Convocation the College received a gift of a gavel from him and upon it was inscribed "This mallet was devised and used by Lord Lister and is presented to the American College of Surgeons by Sir Rickman J. Godlee then president Royal College of Surgeons England, in memory of his visit to Chicago November 1913."

This, indeed was a gracious gesture. Lord Lister was an uncle of Sir Rickman and with this gift a priceless family heirloom came into the possession of the College.

The second episode occurred after the war when the surgeons of the British armies presented the Great Mace with the following inscription: "From the Consulting Surgeons of the British Armies to the American College of Surgeons, in memory of mutual work and good fellowship in the Great War 1914-1918."

The war over the activities of the College grew apace. The acquiring of the College library and the establishment of a Department of Literary Research and the service which that department has rendered to the Fellows of the College is an engrossing tale.

In an attempt to extend clinical teaching, the College in 1919 arranged for sectional meetings so that smaller groups of the Fellows could discuss questions and receive instructions from well known leaders in surgery.

These sectional meetings included one evening set apart when the laity were invited to attend. They would be addressed by local professional men and officers of the College. The subjects presented were medical ones of popular interest. The lay public were to be admitted to professional confidence. Opposition to this innovation by more conservative Fellows was acute however as it has ever been the policy of the College properly to instruct the public in medical matters, the innovation succeeded. Today these sectional meetings are among the most favored of the College activities. We have taken the public into our confidence and by so doing have gained theirs. This we must never lose. The belief of the College that the public should be kept informed concerning medical advances is only a reflection of the present world point of view. Medicine has long since ceased to be a mystery in the minds of educated people. It is our duty to them to help make medical truths understandable, to keep them from being duped by false statements of impossi-

ble cures and in every way indicate that the College was formed for their interest as well as for the profession.

The Department of Clinical Research has expanded its work until now it requires two Boards and five Committees to take care of it.

The Board on Industrial Medicine and Traumatic Surgery has already accomplished much. Industrial medicine is passing through deep waters with the problem of compensation practice.

If this Board can exert its influence toward a solution the College will have performed another great public service. Compensation practice is inherently different from regular practice. The relation of the physician to the patient is not a natural one. I shall not go into the many disagreeable features. Compensation practice in many localities has fallen into such bad favor that many physicians do not, as a general rule, desire to undertake it, thus producing a tendency for concentration into the hands of the unscrupulous. One way in which the situation might be corrected would be to take this type of practice out of the hands of individuals and place it in the clinics of the reputable hospitals of the country. I am aware, that there are objections to this but the point requiring most emphasis, in advocating the establishment of industrial clinics in our reputable hospitals is that such a step could in no wise be interpreted as furthering State medicine. Those clinics would have to be especially organized to handle industrial accidents. Their expenses would be paid for by insurance companies. Being paid clinics they would provide part time positions for a great number of young surgeons. In this way compensation practice would be widely distributed among young medical men of high caliber. In addition, these clinics would provide a tremendous amount of material for statistical and research purposes. Comparative methods of treatment could be followed intelligently and results statistically analyzed so that much might be learned as to how to obtain the best results at the lowest cost in the shortest possible time. This is a particularly good moment to interest hospitals in this project. Many are financially embarrassed, and industrial clinics would be a sure source of considerable revenue. I have talked at some length about this subject because in many of the larger cities the abuses have approached a racketeering stage.

I would like to permit acquaint you men who tonight are being admitted to Fellowship with all the interests which the College has undertaken, but the few I have mentioned may give you some idea of the scope of its many activities.

I would, time permitted, pay personal tribute to each one of the officers and regents, who in the years gone by have sacrificed their time and given of themselves to further the interest of the College.

Often while reflecting on the College, the thought has come to me, that with Finney of Baltimore, Crile of Cleveland, the Mayos of Rochester, Armstrong and Chipman of Montreal, Martin and Deaver of Philadelphia, Cushing of Boston, Ochsner and Kanavel of Chicago, Matas and Miller of New Orleans, Brewer and Stewart of New York, and Ireland of Washington to help him, maybe Dr. Martin did not have so difficult a task in directing the College to its present enviable position.

It has been nevertheless an unselfish service on the part of each and when his term of office expired has continued working even more assiduously for the good of the College. When I say good of the College it presupposes good for humanity and good for each Fellow of the College.

During its short life the scientific contributions of many of the Fellows of the American College of

Surgeons have helped to bring world recognition to American surgery.

It has been a wonderful experience to have lived and worked during this Renaissance of Surgery, but scientific advance is an endless adventure. It is not for us to be satisfied with what has been accomplished but to look beyond.

The College with many of its ambitions already realized has as yet but indented the surface of opportunity.

This child of Franklin Martin's imagination and foresight will be of age in another year. The child has had many watching its growth and many guiding its youthful steps and you, new Fellows, will have to assume the guardianship of its advancing years. You bring new faces, new ideas, and new energy to us, and to you—we give our faith.

Remember always, that the American College of Surgeons has never an axe to grind save one and that must ever be kept, ground to a Toledo edge to blaze the trail through the dark wilderness of sophistry into the sunlight of scientific truth.

NEW VIEWPOINTS IN PHYSICS¹

ROBERT A. MILLIKAN Ph.D. PASADENA, CALIFORNIA

THE past twenty years have been the most surprising and the most extraordinary in the history of science in bringing to light new phenomena completely unpredictable from the simple rigidly mechanical conceptions of the nineteenth century and they have taught the physicist a lesson of modesty open mindedness and reluctance to extend his generalizations beyond the range of his experimental verifications, such as he has not had in the past and such as some other branches of knowledge still lack. It is, therefore, useful for the other sciences and for the public to follow as well as they can the new experimental findings in physics so that they may avoid better than they now do and better than the physicist has done in the past *dogmatic assertiveness without knowledge* whether it be in science philosophy sociology politics, or theology. I am therefore, passing in rapid review tonight first the growth of our ideas about the atomic nature of matter which led to the general acceptance within our century of the kinetic and atomic theories in all branches of what we called the physics of matter.

I am then passing in review the growth of our ideas from 1800 A.D. down in that other half of physics which we call the physics of the ether until by the beginning of this century the wave theory of radiation of all sorts, from wireless waves to cosmic waves, became generally accepted. Everything worked well so long as these two fields were kept separate, but within the past two decades they have revolted completely against such separation. We have gone over into new fields of experimental studies, in which we deal not with large scale phenomena but with isolated elementary processes themselves, and in

these elementary processes, in which, for example one single electron is acted upon by light waves, or X rays, or gamma rays, we have found that ether waves—which represent in our analysis continuous processes—act not like waves but like particles. Also within the past 5 years, we have found experimentally that streams of particles, whether they be electrons or atoms, exhibit all the wave properties which we have heretofore attributed only to radiation phenomena. In other words, the physicist has been obliged to find some way to reconcile apparently contradictory behaviors. Personally I see no way out of the dilemma except to assume that, at bottom, the world of physical experimentation consists of particles, and to try to get wave properties, whether of atoms, electrons, or photons, out of statistical behavior of great swarms of these different sorts of particles.

Efforts are now being made with some success, by theoretical physicists to derive such wave properties out of the statistical behavior of particles, though other theorists prefer to reverse the process and to consider the wave properties as the more fundamental. At any rate, the wholly unexpected discovery that experimentally at least all interference phenomena can be obtained from streams of flying particles represents one of the most amazing developments in the whole history of science and should teach physicists and all mankind the lesson of the danger of extending our generalizations beyond the range of experimental verification. Modern physics has been taught by its mistakes to agree with the poet Shakespeare that there are more things in Heaven and earth than have been dreamed of in our philosophies.

Abstract of Fellowship Address, presented before the Convocation of the American College of Surgeons, St. Louis, Missouri, October 1, 1931.



Robert A. Mullen

OPHTHALMOLOGY, OTOLARYNGOLOGY

SECTION ON OPHTHALMOLOGY

THIS section met in the ballroom of the Statler Hotel on the evening of Tuesday October 18 with Carl Barck M.D. St. Louis presiding. Two papers abstracts of which follow were presented and will be published elsewhere

HIGHWAYS AND BYWAYS IN OPHTHALMOLOGY

HANK BARRAN M.D. San Francisco There are a number of interesting literary artistic and mythological fields of knowledge into which one can dip and find the eye of interest with often a deep speculative value in arousing one's mental processes. The eye in art has been handled differently by different painters of different centuries the eye in statues has been represented as a blank or as composed of jewels the eye in mythology has been given certain values, as for instance the ox-eyed Juno or gray-eyed Athene. Descriptions of the eyes of famous men are found in Plutarch's *Lives*. The eye diseases of famous men such as Goethe Wagner Carlyle Milton Lincoln and others have been fully described by our American author Gould and inferences have been drawn as to their relationship to the general individual and his work. The superstitions concerning the eye are many the evil eye—the origin of the pennies on a dead man's eyes and the representation of a witch with cross eyes. The whole field of ophthalmology contains no more interesting subject of literary research than mention of the eye as an organ expressing love, hate despair tragedy cunning and other emotions as often represented in Shakespeare and the Bible. In gen-

eral the object of this paper has been to indicate many interesting allusions to the eye in literature art and superstition

CHANGES IN OCULAR REFRACTION

EDWARD JACKSON, M.D. Denver Colorado Development of the refractive media of the eye is well started in the first month of fetal life and the lens continues to grow until old age. Changes in refraction occur at any age and are most common in childhood and after middle life. At birth almost all eyes show hyperopia which diminishes with the normal growth of the eyeball. Myopia appears during school life and may increase unless controlled by correcting glasses. Astigmatism may change at any age and does in almost all eyes in later life from changes in the crystalline lens whether these cause cataract or not.

Uncorrected errors of refraction are the most common and serious handicap for the higher occupations and popular amusements of civilized life. They are recognized by the symptoms they cause which can only be understood and met by those who have the full medical education. The decrease of accommodation after middle life, makes slight changes of focus more important and annoying and changes of astigmatism are very often overlooked. The time of life when testing for glasses is often left to the optician is the time that the most careful and exact measurement of the focus of the eye is of special importance and when it gives important information about the existence of degenerative changes in the eye or other parts of the body.

SECTION ON OTOLARYNGOLOGY

AT the meeting of this section in the ballroom of the Statler Hotel on the evening of Thursday October 20 Max A. Goldstein, M.D., St. Louis, presided. The following papers were presented. History and Development of the Operative Treatment of Facial Palsy by Arthur B.

Duel M.D. New York. This paper is published with illustrations in this issue. A second paper on Suppuration of the Petrous Apex in Relation ship to Meningitis was read by Wells P. Eagleton, M.D., Newark, New Jersey and is to be published elsewhere.

SYMPOSIUM CANCER IS CURABLE

THE CURABILITY OF CANCER

FRANKLIN H. MARTIN M.D. F.A.C.S., CHICAGO

MAY I cite briefly the objectives that were in my mind when this symposium on the Curability of Cancer was organized. Through the reports of cancer cures that will follow it is my hope

1. To impress upon the practitioners of scientific medicine, and indirectly upon the public the fact that carcinoma is curable by the use of well known and established methods of treatment.

2. To point out in a convincing manner that if all cases of cancer could be diagnosed early and treated promptly in their incipency the annual death rate from the disease, now recorded as 150,000 in the United States and Canada would be reduced by at least 33 per cent, or 50,000 per year. Even if only one-half of the cancer cases could be diagnosed early and properly treated, the death rate would be reduced by 25,000 per year.

3. To bring together the group of distinguished clinicians here present—an overwhelming authority—to present definite statements of the impressive number of cases of cancer that have actually been cured. This preponderance of evidence, so convincing as an object lesson, will impel ever increasing numbers of the people to demand facilities, through scientific doctors, for annual or semi-annual examinations, so that not only cancer, but any and all diseases may be discovered in their incipency when they are amenable to treatment.

4. To get the maximum of ethical publicity of the reports. This will furnish convincing evidence to our hospitals, our local medical societies, and our already established clinics, and encourage them to furnish facilities whereby every physician who is practicing scientific medicine will have available the necessary equipment and trained aids to insure the comprehensive examination of his patients.

5. To convince the profession and the public that even though cancer is already apparently in a later stage of its development, if it is subjected to proper treatment, its progress may often be stayed, and the disease not infrequently cured to

make these facts so obvious that a general policy will be established to treat systematically every case of cancer in whatever stage of advance not only because of the immediate or remote possibility of a cure but because palliative measures would bring great encouragement and relief of distressing symptoms.

6. To establish a universal policy among physicians and surgeons of reporting cancer cures rather than to present the involved comparative statistics that dwell particularly on the cases not cured.

If we here present accomplish the full humanitarian purposes for which this symposium was organized, the discouraging psychosis that now exists in the minds of the profession as well as the public will be dispelled. A consciousness that cancer is curable will be established in the minds of all fear will be displaced by a spirit of hopefulness and every victim of cancer or suspected cancer will present himself for early diagnosis and treatment.

CANCER CURES—5 YEARS AND MORE

Reported by speakers in this symposium	4,331
Cases registered by American College of Surgeons	1,265
Cases reported in the literature, incomplete recent survey	3,050
Specially reported in this symposium	120
Total	8,820

CLASSIFICATION

Cervix	1,561
Fundus	345
Ovary	42
Breast	3,654
Bladder	233
Prostate	43
Kidney	125
Testis	38
Thyroid	205
Larynx	50
Mouth	267
Stomach	176
Skin	266
Colon and Rectum	116
Bone	20
Other classifications	200
Total cancer cures 5 years and over	8,820

CANCER RELIEF

WALTER C. ALVAREZ, M.D., ROCHESTER MINNESOTA

I HOPE you will be patient with me as I do what I can to pinch hit for a great man I am keenly interested in this program today because I feel the need for it. In spite of the great efforts that have been made to bring patients with carcinoma to the surgeon or the radio-therapist as early as possible, thousands of these people are still waiting months or years before they present themselves. There are several causes for this dilatoriness and some are beyond our control but one at least we must strive harder to remove and this is the hopeless, apathetic, or uninterested attitude of some of the physicians who first see the patients. Some of these doctors seem actually to be doubtful if cancer is ever cured.

So many of you are going to tell us of the splendid results that can be obtained in many cases of cancer that I am not going to say a word about this phase of the subject. The only point I would like to make is that more effort must be made to reach the general practitioner with brief summaries of what can be done in the way of curing cancer in the several parts of the body. For instance we must admit that cancer of the esophagus is hopeless but, when taken early, cancer of the breast or colon or cervix is anything but hopeless. In the past, too much of this information has been published in special journals which are never seen by the general practitioner.

The physician must be taught, also, that even when, in a given case the disease looks incurable there is always a gambler's chance that with removal of the main growth health will return and metastatic growths will lie dormant for several years. A 5 year cure is wonderful but so also is a 2 year or a 3 year cure.

Finally, the profession must be encouraged to take better care of the forgotten man the patient with inoperable carcinoma. Most of us physicians hate to see these poor people. We feel uncomfortable when talking to a man who has just been condemned to death we hate to see the suffering in the faces of his relatives we don't know what to do with him and as a result too often we say as little as possible we urge him to go home, and we abandon him to the rapaciousness of the quack who lies waiting for him around the corner.

This is not right we must not shirk our responsibilities in this way, and besides, in most cases there is much that we can do to add to the comfort of these patients. Often it pays to remove or

clean up the main growth. We may perhaps short-circuit an obstructing tumor in stomach or colon and thus give many months of good health. We can often clean up foul discharges and some times we can stop fiendish pain with a dose of roentgen rays. Occasionally to our astonishment, irradiation will even work a cure when none was expected.

We can do much to keep up the morale of the patient and his family, it is terrible to have to sit by idly and watch a loved one die and the kindest thing we can do for many of these families is to keep them busy doing something if we don't they are almost certain to fall into the hands of quacks and scoundrels.

Too often we do not even make a fight to see that the patient has enough morphine to relieve his pain and we do not always see to it that he has harmless sedatives so that he can sleep at night. (We now have the new drug Dilaudid which can be taken by mouth it relieves pain much as morphine does, and it probably is not habit forming.)

In some cases we can raise the patient's resistance to the growth of the carcinoma with the help of a richer diet, injections of foreign protein, and transfusions of blood. There is no question that some persons have an enormous hereditary resistance to the development of cancer, and this resistance should be conserved.

In some cases it is worth while to try injections of lead, and I am hopeful that something will come of the experiments in which the whole body is being irradiated over a period of time. I would be willing to let a patient try anything that is not definitely injurious.

Unfortunately many physicians will hesitate to treat incurable cancer with any degree of hope and optimism for fear of being criticized by their colleagues. They will fear the accusation that they are treating the patient merely for the money that is to be made. This fear of blame would be largely removed if a great medical organization like this College were to approve officially of and advocate more palliative treatment.

It is reported in an ancient manuscript that Christ once on the Sabbath day saw a man working hard to shore up the foundations of a poor widow's house being undermined by a swollen stream. He said to him, Man if thou knowest what thou art doing blessed art thou, but if thou

TABLE I.—SUMMARY OF SALIENT RESULTS OF TREATMENT OF CARCINOMA AT THE MAYO CLINIC*

Organ involved		Percentage of patients living†	
		1 year after	1 year or more later
Stomach	795 patients traced following resection		24
Colon and rectum	603 patients traced following resection	47	23
Freedom of uterus	Lesions suitable for excision alone Lesions suitable for excision and irradiation Inoperable lesions treated by irradiation	27 26	23 21 13
Cervix of uterus	1465 patients traced Operable Borderline Inoperable Modified by previous treatment		27 61 7 25
Breast	179 patients operated on Without lymphatic involvement With lymphatic involvement	56 4	67 28
Kidney	57 patients operated on; some irradiated also		43
Bladder	406 patients treated by surgery and irradiation		28
Prostate gland	400 patients traced 184 cases of prostatectomy		13
Esophagus	228 patients traced, all died		
Thyroid gland	364 patients operated on 37 patients traced following operation and irradiation 71 patients traced after irradiation alone	33	71 54
Face	26 cases Without involvement of cartilage or bone With involvement of cartilage or bone		93 74
Eye lids	11 cases		43
Outer ear	24 patients treated	47	89
Anterior of larynx	27 patients with tumor primary in larynx 70 patients with tumor primary in trachea		89 18
Mouth	Surgical removal early Irradiation alone		16 13
Vagina and base of tongue	49 patients traced	16	
Larynx	84 patients traced Carcinoma graded 1 Carcinoma graded 2 Carcinoma graded 3, all died	27 25	
Lung	47 patients treated by irradiation; life prolonged		
Gall bladder	20 cases studied		3
Appendix	27 patients traced, no deaths from carcinoma		

*It must be remembered that the figures given here represent results obtained only in cases in which the disease could be attacked with a small probability of success.
†All patients traced.

knowest not what thou art doing cursed art thou! If we physicians can bring ourselves to help these poor patients because of our pity for them and our feelings of consecration to our work, I am sure we will be blessed.

In some cases of course the wise and kindly physician will advise against costly treatments if he thinks that they are quite hopeless and if the

patient is so poor that he must try to leave every thing possible to his wife and children.

Let us then go forward with a clearer knowledge of the type of case in which we most certainly can cure cancer as well as with a greater feeling of responsibility toward the many poor sufferers whom we now turn away with barely a word of advice.

IS CANCER CURABLE?

J M WAINWRIGHT M D F A C S SCRANTON PENNSYLVANIA

IT is the experience of every one whose lot has led them to special interest in cancer surgery frequently to be asked "Do you ever cure a cancer?" Many times the question comes from those who should know better.

Other papers in this group will deal with results in large series of cases. This paper will not consider statistics or percentage results but will relate in brief a few cases which give somewhat striking proof that we do cure cancer.

THE BREAST

1 Miss C G was operated on at the age of 61 on October 13 1903. Her tumor had been noticed 6 years before. It was large. The microscopic examination was unquestionable and it showed infiltration of pectoralis major muscle fibers. This was the writer's second breast operation and it was not one to be proud of. This old lady was carefully followed. She remained well and active. The photograph shows her in August, 1923, at the age of 85 still in the active direction of her farm. In January 1930 she was found dead in bed at the age of 87 26 years and 3 months after operation. She had been examined a few months before and found apparently cancer free and with no special complaints (Fig. 1).

2 A doctor's mother aged 49, was operated on on January 20, 1910. She had had her tumor for 1 year. The microscopic examination was unquestionable and the axillary glands were involved. This lady at this writing is in good health, aged 71 and cancer free 22 years and 9 months later.

3. Another patient is well and cancer free at the age of 66 years 20 years after operation.

MELANOMATA WITH METASTASES

(than which few things are more malignant)

1 S. S. Operated on August 25 1905 aged 36. Four months before he had noticed a black tumor over the right scapula. Two months later he noticed a mass in the axilla. Within the next few months metastatic tumors were removed from the left shoulder and the opposite axilla. He had four operations in all the last January 6 1906. Microscopic examination unquestionable. This man is under close observation and is well and cancer free at this writing 27 years and 2 months after the first operation.

2 H. L., was operated on on January 7 1915. He had a rough pigmented mole on the right arm which a few months before metastasized to the glands in the neck. The mole and the glands were removed. The microscopic examination was unquestionable. This man is under close observation. Last examined July 1932, at which time he was well cancer free, and working regularly in the coal mines 17 years and 6 months after operation.

3 Mrs. A. C. operated on on August 23, 1912 aged 62. She had a melanotic patch under the right thumb nail. Six months previously it metastasized to the right axilla. Amputation of the thumb and removal of a mass the size of a baseball from the axilla. This patient kept under close

observation and remained cancer free and did hard farm work in the fields. She died suddenly of apoplexy aged 77 15 years after operation.

THE LIP

1 E. H. operated on on April 21 1904 aged 45 years for cancer of the lip. Section was unquestionable. Twice within the next few months the involved glands were removed from the neck. She was kept under close observation and remained well and cancer free. She was killed in an accident 23 years and 6 months after operation aged 68.

THE UTERUS

1 Mrs. M B aged 20 years. Treated by radium July 1 1920. She was in a very distressing stage of emaciation and cachexia. The entire vaginal vault was filled with a large cauliflower like mass and a mass could be felt above the pubes "as big as a grapefruit." Why I treated her with radium I do not know. It was in my early experience with radium and I knew no better. She was discharged a few weeks later still in very poor condition and her death within a few weeks seemed certain. For several months no notice whatever was taken of follow-up letters and finally a medical friend in her town was requested to visit the family "to get for our record the date of death." He replied, "not dead. I found her in the yard hanging up the washing." This woman has remained well and 12 years after treatment in July 1932 she was examined and found cancer free. She was well nourished and doing the usual hard work of a foreign woman the wife of a miner.

These cases surely determine the *q. e. d.* to the claim that we do cure cancer. Furthermore, these cases represent the work of 20 sometimes nearly 30, years ago. Hundreds of other surgeons were curing cancer at this time and long before as a small army of patients can attest.



Fig. 1 Miss C. G. taken on her farm at the age of 85 years, 24 years after operation for breast cancer.

Of more hopeful value still is the fact that since the patients of 20 years ago were operated on technical surgery has greatly advanced in its own field and more important still, there has been added the great advantage of radium improved roentgen technique and equipment, and the electro-knife. In some cases radiation alone has become more efficient than surgery. In most cases it is an indispensable adjunct.

Many surgeons who were producing permanent cures in the first decade of this century are still working with vastly increased experience and skill. Younger men much better trained than the older men when they began are constantly entering the lists and with the physical aids just noted the number of permanent cures in the present decade will be many times greater than for the period of 20 years ago.

END RESULTS OF RADIUM THERAPY IN 475 CASES OF CERVICAL CANCER

FLOYD E. KEENE, M.D., F.A.C.S. PHILADELPHIA

FROM 1913 to July 1926 475 cases of carcinoma of the cervix were treated with radium in the John G. Clark Clinic of the Hospital of the University of Pennsylvania. More than four-fifths of the patients presented advanced malignancy and in only about 12 per cent could the lesion be classified as belonging to Stage I.

During the period covering the early years of this report, the routine treatment consisted of 2,400 milligram hours of radium filtered by 1 millimeter of silver or 2 millimeters of brass and 1 millimeters of soft rubber tubing, with repetition of the irradiation at the end of 6 weeks. During the later years the second application was omitted, re radiation being employed only when evidence of continued growth was found. Deep X-ray therapy supplemented radium in only 5 patients. The results show that re radiation was of palliative value but it did not increase the percentage of ultimate cures.

Complete follow-up data are available in over 80 per cent of the entire series and patients not traced are classified as dead from cancer. Seventy-three patients were free from any evidence of malignancy 5 years or more after the initial treatment which represents a total salvage of 15.24 per cent. In justice to radium treatment, however, it should be stated that during the earlier years included in this report hysterectomy was performed when the lesion was operable and only the advanced cases were subjected to radium. From 1920 to 1926 both the early and the late lesions received radium treatment and in the group belonging to these years the total salvage was

18.28 per cent. Ninety two cases are classified as belonging to Stages I and II. Thirty of these, or 32.60 per cent, showed no evidence of disease 5 years or more after treatment was given. The lesions were more extensive in 383 of these, a salvage of 5 years or more was obtained in 43 or 11.22 per cent.

In the 58 patients whose lesions were classified as Stage I either radium alone or caustery amputation plus radium was used with a cure rate of 39.65 per cent the best results followed caustery amputation and irradiation, for in 34 patients thus treated 18, or 52.94 per cent, were free from evidence of malignancy more than 5 years after the initial treatment.

Specimens from 168 patients have been graded according to the classification of Martaloff. The striking feature of this analysis is the low curability rate (13.05 per cent) in the spindle cell type which is recognized as being highly radiosensitive. The best results, 36.66 per cent, were obtained in the transitional cell group. In the adenocarcinoma and the epidermoid types, the results are practically the same (17.85 per cent). It would seem, therefore, from these findings that prognostically grading according to cell type is not of much practical value.

Disatisfied with our results, we have entirely reorganized our methods of attack during the past year. This modification consists not only in the technique of radium application, but the addition of routine roentgen therapy and the adoption of a plan whereby the problem as a whole can be more efficiently handled.

END RESULTS OF THE TREATMENT OF MALIGNANT DISEASES AT THE CLEVELAND CLINIC

GEORGE CRILE, M.D., F.A.C.S. CLEVELAND OHIO

My associates Dr W. E. Lower, Dr T. E. Jones, Dr U. V. Portmann, Dr R. S. Dinsmore, Dr W. V. Mullin, and I have seen 8,679 cases of malignant tumors of the various organs and tissues of the body. Of these, 2,756 were treated by operation only, 1,399 by operation and radiation and 1,931 by radiation only, and 2,593 were not suitable for treatment. Four thousand and fifty-nine of the patients seen prior to 1928 have been traced. Of these, 1,182 have survived for 3 years or more and 737 for 5 years or more.

Our series includes 786 cases of cancer of the skin and subcutaneous tissues. Of these, 262 were treated by operation only, 75 by operation and radiation, and 360 by radiation only. Among the 215 patients seen before 1928, 100 have survived for 3 years and 52 for 5 years.

We have seen 618 cases of cancer of the buccal surfaces and jaws of which 300 seen before 1928 have been traced. Among these, 94 patients have survived for 3 years and 53 for 5 years. In this series, 220 patients were treated by operation alone, 165 by operation and radiation and 174 by radiation only.

Of 162 cases of cancer of the larynx, 47 were treated by operation only, 31 by operation and radiation, and 28 by radiation alone. Fourteen patients have survived for 3 years and 9 for 5 years.

Of 292 cases of malignant diseases of the thyroid gland, 79 were treated by operation alone, 131 by operation and radiation, and 44 by radiation only. One hundred and eighty-five of these patients have been traced. Of these, 55 have survived for 3 years or more and 37 for 5 years.

Of our total of 1,555 cases of cancer of the breast, 919 of those seen prior to 1928 have been traced. Of this series, 437 patients have lived for 3 years and 307 for 5 years. In this series, 860 patients were treated by operation only, 500 by operation and radiation, and 57 by radiation only.

We have seen 2,264 cases of malignant tumors of the gastro-intestinal tract and other abdominal

tumors which include 140 cases of tumors of the esophagus, 726 of the stomach, 69 of the gall bladder and ducts, and 841 of the large intestine and rectum.

Thirteen patients with carcinoma of the stomach have survived for 3 years and 7 for 5 years. Eighty-nine patients with malignant tumors of the large intestine and rectum have survived for 3 years and 48 for 5 years. In the latter series, 246 were treated by operation only, 78 by operation and radiation, and 142 by radiation only.

We have seen 553 cases of malignant tumors of the urinary tract, 143 of the kidney, 389 of the bladder, 18 of the urethra, and 3 of the ureters. Of the patients with tumors of the kidney, 16 have survived for 3 years and 7 for 5 years. Of the patients with malignant tumors of the bladder, 150 were treated by operation only, 45 by operation and radiation, and 93 by radiation alone. Of these, 47 have survived for 3 years and 30 for 5 years.

Our series includes 464 cases of malignant disease of the male reproductive organs, including 336 cases of tumors of the prostate gland. Of the patients in the latter group, 72 were treated by operation only, 19 by operation and radiation, and 121 by radiation only. 24 patients have lived for 3 years and 9 for 5 years or more.

We have seen 1,171 cases of malignant diseases of the female reproductive organs including 676 of the cervix and 246 of the fundus. Of the cases of cancer of the cervix, 121 were treated by surgery alone, 34 by surgery and radiation, and 357 by radiation alone. While of the cases of cancer of the fundus, 123 were treated by operation alone, 24 by operation and radiation, and 63 by radiation alone. Of the patients in this total series, 159 have lived for 3 years, 98 for 5 years.

Exclusive of carcinoma of the jaw, we have seen 176 cases of malignant disease of bone. Forty-four of these were treated by surgery alone, 31 by surgery and radiation, and 51 by radiation alone. Fifteen have survived for 3 years and 10 for 5 years.

REPORT ON FIFTY CASES OF FIVE YEAR CANCER CURES

DONALD GUTHRIE, M.D., F.A.C.S., BAYNE, PENNSYLVANIA

I WISH to report briefly upon 50 cases of 5 year cancer cures taken at random from our files the present conditions of which have been carefully investigated in a follow up clinic and found to be satisfactory

1 Twenty-five breast cases, 8 showing axillary involvement at the time of operation. Of these 8, 2 are well 5 years 1 well 6 years 2 well 7 years 2 well 8 years and 1 well 10 years.

2 Eight cases of cancer of the cervix. One treated by panhysterectomy is well 7 years. Of 6 cases upon whom radium alone was used, 3 cases are well 7 years and 3 cases well 8 years dosage 2,400 to 5,500 milligram hours.

3 One case of cancer of the vaginal wall wore a pessary 8 years without removing it. She has been well 12 years and had 1 dose of radium 1,500 milligram hours.

4 Five cases of cancer of the body of the uterus. Of 4 treated by panhysterectomy 1 is well 5 years 2 are well 6 years and 1 is well 7 years. One treated by radium is well 8 years and had 4,500 milligram hours.

5 Four cases of cancer of the stomach. One is well 6 years 1 8 years 1 10 years and 1 20 years.

6 Five cases of cancer of the large intestine and rectum. One cancer of the ascending colon is well 17 years 1 cancer of the transverse colon with obstruction, age 18, is well 12 years 2 cancers of the sigmoid, 1 is well 16 years and 1 well 12 years

1 cancer of the rectum age 76 is well 6 years.

7 Two cases of cancer of the bladder. One had cautery excision and radium, 1,000 milligram hours, and is well 10 years 1 had cautery excision and is well 10 years.

8. One case of cancer of the urethra had radium 1,650 milligram hours, with excision of the inguinal glands and suprapubic cystostomy and is well 10 years.

Unquestionably the campaign of education of the profession and of the laity by the various agencies upon cancer have done much to enlighten the public and cause our patients to come earlier for examination than formerly yet it is discouraging still to have many inoperable cases of cancer present themselves for relief and it is surprising today to have not a few patients request that, if the lesion proves to be cancer no attempt be made to help them by removing it. This happens frequently and one can interpret the feeling on the part of the patient in no other way except that in the minds of many there remains the firm belief that cancer cannot be cured. Reports of 5 year cures will do much to correct this misbelief and this effort of the American College of Surgeons to collect 5 year cures of cancer and publish them is indeed a noteworthy movement.

If we are to impress the laity with the fact that cancer is curable let us publish our lists of cures and let us all choose our cases for operation and radiation with greater care.

FOLLOW UP STATISTICS OF FIVE YEAR CURES IN CANCER

FRANK H. LAHEY M.D. F.A.C.S., BOSTON, MASSACHUSETTS

OF 6,535 patients operated upon for goiter 187 had definite cancer of the thyroid (2.8 per cent). We can divide all of our thyroid cancer cases into 3 groups (1) of low malignancy (2) of moderate malignancy (3) of severe malignancy. Of the patients with cancer operated upon 5 or more years ago 17 were in group one, either adenoma with blood vessel invasion or papillary adenocarcinoma. Of these, 15 are now alive and well. One could not be followed and one died 5 years after operation not of malignancy.

In group two are the cases of adenocarcinoma in which there is some hope of cure. We have 8 cases in this group one is alive over 5 years after operation and 7 are dead. Group three consists of the almost hopeless malignancies—giant cell and small cell carcinoma and fibrosarcoma. Of these there were 12 cases. One is living over 5 years and 11 are dead.

The salvation of patients with malignancy of the thyroid is in the prophylactic measure, of removing adenomata while they are still benign,

since it is in these that practically all malignancy of the thyroid arises.

We have 4 patients alive and well 5 or more years after partial gastrectomy for proved carcinoma or sarcoma of the stomach, 1 at the end of 5 years, 2 at the end of 6 years, and 1 at the end of 9 years. The salvation of patients with carcinoma of the stomach is in early bismuth X rays of the stomach in all patients with any change of digestive function, loss of appetite or distaste for food.

Of proved carcinoma of the breast, of 82 cases 28 (34 per cent) are alive and well at the end of a 5 year period. Many of these lesions have been graded as to the degree of malignancy, but time does not permit this discussion.

The salvation of patients with carcinoma of the breast lies in the frequent examination of the breasts by the patients themselves, the examination of doubtful areas by the physician or surgeon, and finally the examination by the pathologist of biopsy specimens from areas considered probably malignant by the examining physician or surgeon.

Of 47 radical resections of the colon and rectum done 5 or more years ago, representing an operability of 45 per cent, 14 (30 per cent) are alive and well now. Nine were early cases without glands, 5 showed local glands or glands in the vicinity of the growth.

The salvation of patients with carcinoma of the colon or rectum is in routine and adequate rectal examinations in all patients examined for whatever cause, in the submission of all patients who have any change whatever in colonic function to early bismuth enemas and fluoroscopy and in proctoscopy of all patients with rectal bleeding or discomfort.

Surgery had proved that it can produce lasting cures in cancer patients if the diagnosis is made early. Early diagnosis is in the hands of the family doctor and if he is to make more early diagnoses, he must do more than the sometimes merely casual examination—he must make the examination more comprehensive even then at times he will be compelled to make his diagnosis upon clinical evidence which is not always convincing but only suggestive of malignancy.

THE CURABILITY OF CANCER

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CANCER originates in a *single cell* which has taken on abnormal growth. For a certain definite period of time then cancer is a local disease and as such is amenable to cure by radical surgical measures. In assessing the curability of any given case three factors are of paramount importance: first the accessibility of the growth, second the grade of malignancy, and third, the duration and extent of the disease.

When the disease has involved parts far beyond the primary lymph nodes, cancer from the standpoint of cure is practically hopeless. If every case were treated by adequate surgical methods at the onset of symptoms the percentage of cures would rise rapidly.

It goes without saying that a comprehensive knowledge of the mode of permeation of the cancer cells throughout the different organs and tissues of the body together with an exact knowledge of the lymphatic drainage of the part involved is absolutely essential to the intelligent treatment of cancer.

Two cases of epithelioma of the hand were brought to my attention some years ago. Both had been operated upon by first class surgeons, with successful removal of the local growth. Nine months later the first patient developed a mass in the axilla. Two years later the second patient developed a mass in the axilla. Both died of dissemination of the growth. It is interesting to note that in neither of these cases was the epitrochlear gland involved, the lymph drainage from the back of the hand passing directly to the axilla.

The next case I saw had had a small ulcerated nodule on the back of his hand for over a month. His family doctor had removed this nodule, and referred the case to me for further consideration because the pathologist had pronounced the growth malignant. I excised the scar widely and as deeply as possible taking away all the subcutaneous tissue down to the extensor tendons. Two weeks later the lymph glands were removed from the axilla, and radium was inserted. The

glands, though not macroscopically involved, showed cancer cells on microscopic section. This patient is alive and well 12 years later. The moral is obvious.

It would seem to be a sound surgical procedure to remove the primary lymph glands at some time subsequent to removal of the tumor. A malignant cells en route from the primary growth to the first group of filters are thus given time to reach their destinations where they are held up for some time. The lymphatic vessels do not appear to harbor cancer cells until the glands beyond are first choked and no longer able to receive their cargos from the primary growth. This later removal of lymph glands does not apply where as in the breast, a block dissection is made of all possibly involved structures.

The series of cures here presented are taken from my own private records. In every case the diagnosis was confirmed by an expert pathologist, at the time of operation. Reliable follow-up records have also been obtained in every case presented in this series. The period of freedom from cancer following operation extends from 5 to 28 years in this group.

CURED CANCER CASES—5 TO 28 YEAR CURES

	Cases	Years
Lip	8	5 to 20
Breast	36	5 to 25
Uterus	9	5 to 10
Stomach	3	7 9 and 20
Colon and Rectum	14	5 to 25
Tongue	2	10 and 1
Ovary	2	12 and 9
Kidney	1	5 and 8
Skin of Leg		11 and 12
Skin of Hand		12
Penis	1	17
Bladder		8
Total	8	

Cancer of skin of leg and hand—2 cases cured, 1 and 12 years.

One case of cancer of the skin of the leg is of special interest. A medical man had noted an ulcer on the lateral aspect of the leg midway between the knee and ankle. It had been present 4 months and was the size of a 50 cent piece. The biopsy report was epithelioma. The ulcer was widely excised and the fascia dissected off the underlying muscle. Three weeks later the surface was skin grafted and the popliteal glands removed. No definite glandular involvement was found.

He has had no trouble now over 6 years.

Cancer of the penis—1 case, 7 year cure.

The penis was amputated 3 inches behind the corona and the inguinal glands on both sides removed 5 weeks later.

Epithelioma of the lip—3 cases of carcinoma of the upper lip living 13 and 20 years; 6 cases of carcinoma of the lower lip living 5 to 5 years.

In removing an early growth from the lower lip, a V excision is used, going 1 1/2 to 2 centimeters beyond the

demonstrable limits of the tumor. In larger growths a modification of the Dieffenbach or the Trendelenburg principle is used. The submandibular and submental lymph nodes on the affected side are removed 2 weeks later, whether palpably enlarged or not. Fifty milligrams of radium screened in platinum and brass and in a rubber tube is placed in the cavity. This is moved at intervals along the length of the dissection, and taken out in from 24 to 36 hours. A modification of Dieffenbach's principle as applied to the lower lip was used in the restoration of the upper lip after removal of the tumor. It is interesting that 1 of the 2 cases of cancer of the upper lip was in a woman.

Cancer of the tongue—3 cases, 0 and 11 year cures.

The case cured 10 years had a hemiglossectomy. Two weeks later a block dissection of the glands of the neck was done on the affected side. The only gland involved was the jugulodigastric, this being the gland which, as Burtin points out, is early involved in cancer of the tongue. It is interesting that though the growth was at the tip of the tongue the submental and submandibular glands were missed and the more remote jugulodigastric gland involved. In the other case the growth had crossed the midline in the anterior two-thirds. The glands in both submandibular regions were grossly involved and were removed at two sittings subsequent to the glossectomy. In both cases radium was used after each operation.

Cancer of the stomach—3 cases, 7 9, and 20 year cures.

The first patient, alive and well 20 years after operation which was done in two stages. A posterior gastrojejunostomy was first done and 3 weeks later a partial gastrectomy. The 2 other cases had a Polya operation. One patient, having been well for 9 years, developed cancer in the remaining part of the stomach but at some distance from the suture line. This would seem to be a new development of cancer and not an extension of the previous growth.

Cancer of the rectum—1 patient alive and well 28 years after operation and 5 patients are alive and well 5 to 19 years after operation.

In the first patient, still alive and well 28 years after operation, the lower part of the bowel was removed by the old Krask's method, without a preliminary colostomy. The sacral anus, without sphincteric control, has not been found to be a great inconvenience. In the second patient, alive and well 12 years after operation, a permanent left inguinal colostomy was done 18 days before the radical operation. The rectum, the peritrectal and the perineal lymph nodes were removed by the sacral route, a third part of the sigmoid being left below the colostomy. In more recent cases, the two stage abdominoperineal method was used, allowing 3 to 4 weeks between the abdominal and the sacral parts of the operation.

Cancer of the recto sigmoid—1 male alive and well 12 years after operation and 1 female died of pernicious anemia 11 years after operation.

In the first case, an abdominoperineal operation was done. The abdominal stage consisted of dividing the inferior mesenteric artery above its anastomotic branch to the marginal loop of the sigmoid, and mobilizing the lower part of the pelvic colon. A temporary colostomy at high up in the sigmoid as possible was then made and the abdomen closed. Not until 6 weeks later did the patient's condition seem favorable for the second stage. This consisted of wide resection of the involved part of the rectum by the transsacral route, the sphincters being saved at the same time. The bowel was reunited over a rubber tube passed through the anus. The colostomy was closed some months later. This man is now in perfect health, and has a normally functioning bowel, with no sign of stricture. The second patient lived 11 years and died of pernicious

anemia without any sign of recurrence of cancer. When I first saw her she had acute obstruction, a small perforation and spreading pelvic peritonitis. The pelvis was drained and a colostomy was established. Three months later an abdominal resection of the strictured segment was done, and the bowel reunited over a large rubber tube passed out through the anus. The colostomy was closed a month later.

Cancer of the sigmoid—4 cases, 5 to 12 year cures.

When the growth is sufficiently high up in the sigmoid to allow it to be mobilized to the surface, I have used as the method of choice, the so-called Mikulicz, or three-stage operation. If there is obstruction a rubber tube is at once "parastomized" into the upper part of the loop. The tumor may be left on the abdomen for a few days, or it may be removed at once, as the exigencies of the case demand.

Cancer of the caecum—1 case, female 15 year cure 1 case female, 12 year cure.

The operation performed in the first case was resection of the right colon closure of the end of the transverse colon and an end-to-side ileocolostomy in one stage. This patient, who was only 24 years old at the time of the operation, is still in perfect health.

In the second case the ends of the ileum and transverse colon were brought out at the side. The spur was later clamped and the opening finally closed.

Cancer of the breast—9 patients, alive and well from 15 to 25 years after operation, 9 patients, alive and well from 10 to 15 years after operation and 18 patients, alive and well from 5 to 10 years after operation.

Every tumor of the breast should be regarded as cancer until proved otherwise. Even the typical mobile fibroadenoma in one of my cases turned out to be associated with a cancerous growth.

In the 9 cures ranging from 15 to 25 years, no X-ray or radium was used. During this period the tumor was removed and the incision closed. If the tumor was proved to be malignant by the pathologist a few days later the patient was taken back to the operating room and a radical operation was performed. Every attempt was made to avoid touching or re-entering the original cavity.

In the 27 cures ranging from 5 to 15 years, a rapid-resection biopsy was done at the time of operation. In the management of these cases, three distinct methods of procedure were followed.

First, in cases of cancer age, with a fairly typical clinical picture of carcinoma, a radical Halstead was done immediately.

Second, in cases of cancer age where the diagnosis of carcinoma was doubtful, an amputation of the breast was done first. If the pathologist reported malignancy the radical operation was forthwith completed.

Third, in younger women with doubtful tumors the growth only was excised if reported malignant, the radical operation was then carried out.

The ideal method of procedure in doing a radical breast operation is to begin with the dissection of the axilla, and remove in one piece the lower part of the pectoralis major

the pectoralis minor, the fat, and glands from the axilla, the skin and breast including the pectoral fascia down to the ribs. It is important to include in the dissection the highest gland in the apex of the axilla under the axillary vein where it passes over the first rib into the thorax.

In this situation this gland is easily missed.

Cancer of the corpus uteri—3 cases, 5 to 16 year cures 1 case (sarcoma) 14 year cure.

In carcinoma of the body of the uterus it was formerly my practice to do an abdominal panhysterectomy. I now use the vaginal method because it can be done quite radically and with a lower operative mortality.

Cancer of the cervix uteri—5 patients alive and well 5 to 15 years after operation.

Fifty milligrams of radium (screened) was inserted into the cavity of the cervix for 24 hours. Four weeks later a radical vaginal hysterectomy was done the ureters being retracted laterally and the parametrium excised widely (Schauta operation). Radium was again used, 50 milligrams being inserted into the cavity originally occupied by the uterus, and left in for 24 hours. I now believe it best to give more intensive pre-operative radiation, and omit the immediate postoperative radiation.

Carcinoma of the bladder—1 case, 8 year cure.

The growth here was fortunately situated in the fundus. It was excised widely through a suprapubic cystotomy incision. The patient was a woman 76 years of age and lived to the age of 84 without any recurrence.

Carcinoma of the kidney—2 cases, 5 and 9 year cures.

The procedure in these cases was the usual nephrectomy plus free removal of the perinephric fat. Into the cavity left was inserted a drainage tube large enough to contain a 50 milligrams capsule of radium. The latter was left in situ for 36 hours being moved the length of the capsule at 12 hour intervals. The value of radium treatment in these cases is questionable.

Carcinoma of the ovaries—3 cases, 12 and 19 years.

Simple oophorectomy was done in each case. One patient developed carcinoma in the remaining ovary 19 years subsequent to the first. She refused further operation and finally died of general abdominal carcinomatosis.

CONCLUSIONS

1 The educational campaign by the profession among the laity for the earlier recognition of the signs suggesting cancer and immediate attention thereto, should be persisted in and extended to reach all classes.

2 Every medical teaching center should have a tumor clinic as part of its organization.

3 Some one has said that he who treats cancer should be radiologically trained and surgically minded. I would say that he who treats cancer should be surgically trained and radiologically minded.

FIVE YEAR CURES OF GYNECOLOGICAL CANCER

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THE 5 year cures to be reported are drawn from the files of the gynecological service of the Roosevelt Hospital and the patients were treated during the years from 1910 through 1925. These years have witnessed fundamental changes in cancer therapy so that it is not surprising that the majority of the successful cases were treated in the latter part of this 16 year period.

The apparent improvement in results may be attributed to several factors, such as the advent of radium which was introduced into the Roosevelt clinic in 1917 and the use of the high voltage X-rays which was begun in 1924. But besides these technical innovations, there has grown up with us as elsewhere a special sense of responsibility for the patient with suspected or proved cancer. This newer attitude has manifested itself on the one hand in more conscientious efforts at early diagnosis, on the other in the organization of a follow-up clinic as a check upon the efficiency of treatment.

The Roosevelt gynecological service treats on an average about 40 cases of cancer in a year. Its radiological equipment is limited to 140 milligrams of radium and a single high voltage X-ray machine. It is probable that a majority of cancer cases throughout the country are treated in institutions of about this size, so that the rate of cures I shall report may be taken as typical of that which widely prevails throughout the United States or is at least readily attainable.

Before reporting 5 year cures let me state that pathological reports giving confirmation of the diagnosis are on file at the hospital for all of these cases and for all but a few the microscopic slides have been reviewed and the diagnosis verified within the last 2 years.

The treatment of cancer of the cervix has varied greatly over the period noted so that cures must be reported upon special groups dependent upon the type of treatment. From 1910 to 1916 the only significant treatment for cervical cancer was hysterectomy. In these years a total of 126 cases of all stages of the disease were observed. Nine 5 year cures resulted. (For the 113 primary cases, the operability rate was 60 per cent, the absolute 5 year cure rate 71 per cent.) Two patients of this period are known to have been living and well 18 and 20 years, respectively after their operations.

From 1917 to 1920 when radium was first being used, either alone in the advanced cases or as a preliminary to hysterectomy 84 cases were treated, with 5 year cures in 11. (For the 78 primary cases the operability was 43 per cent, the absolute 5 year cure rate 14.1 per cent.)

From 1921 to 1923 radium was given increasing scope and the indication for hysterectomy was further restricted. Forty three cases were treated, with 11 cures. (For the 37 primary cases the operability rate was 27 per cent, the absolute 5 year cure rate 29.7 per cent.)

In the years 1924 and 1925 when radium was used almost exclusively 46 cases were treated, with 5 year cures in 8. (The absolute 5 year cure rate for the primary cases was 18 per cent.)

The cases of carcinoma of the corpus have been treated more or less uniformly throughout the period and only one fifth of the primary cases were regarded as inoperable. Of the total of 90 primary and recurrent cases there are 22 known cures. (This represents an absolute 5 year cure rate of 25.8 per cent in the 85 primary cases.)

The cases of carcinoma of the ovary can also be reported as a single group but offer a discouraging figure since only 5 cases out of a total of 66 are known to have been well after 5 years. (The 5 year cure rate for the 58 primary cases was 8.6 per cent.)

Among the less common forms of gynecological cancer there can be reported 5 year cures in 4 among 17 cases of cancer of the vulva and 1 in 7 cases of vaginal cancer. Among a miscellaneous group consisting of 1 case of primary tubal cancer, 3 cases of chorio-epithelioma, 3 cases of myosarcoma of the uterus, 4 cases of sarcoma of the ovary and 16 cases of generalized peritoneal carcinoma of undetermined origin there were no cures.

To summarize, the Roosevelt clinic has to offer the following 5 year cures:

TABLE 1.—TOTAL FIVE YEAR CURES

	5 year cures	Total cases
Cancer of the cervix	30	299
Cancer of the corpus	22	90
Cancer of the ovary	5	66
Cancer of the vulva	4	17
Cancer of the vagina	1	7
Miscellaneous	0	27
Total	71	506

TABLE II—EXTENT OF DISEASE WHEN TREATMENT WAS INSTITUTED

	Early		Intermediate		Advanced	
	Total cases	Percent ages	Total cases	Percent ages	Total cases	Percent ages
Cervix	24	8	31	17	224	75
Corpus	26	29	27	30	37	41
Ovary	9	14	16	24	41	62
Vulva	19	53	7	41	1	6
Vagina	1	14	0	0	6	86
Miscellaneous	0	0	1	4	26	96
Total	60	14	102	20	335	66

The total number of cancer cases treated in these years was 506 so that it may be said that approximately 1 woman in 7 who came for treatment was well for at least 5 years after her treatment.

The figure of 1 in 7 represents an absolute minimum inclusive of all advanced and recurrent cases, and with the acceptance as failures of all cases that could not be traced. Table II giving a somewhat arbitrary division of cases according to the extent of the disease, shows that almost two-thirds of the cases were advanced when they first came for treatment. From this table it becomes clear that the unfavorable character of

TABLE III—PERCENTAGE OF FIVE YEAR CURES AMONG TRACED CASES IN DIFFERENT STAGES OF THE DISEASE

	Early			Intermediate			Advanced		
	Total cases	Percent	ages	Total cases	Percent	ages	Total cases	Percent	ages
Cervix	75	41	8	31	30	0	224	75	0
Corpus	63	30	0	27	30	0	37	41	0
Ovary	33	31	0	16	24	0	41	62	0
Vulva	50	0	0	7	41	0	1	6	0
Miscellaneous	100	0	0	1	4	0	26	96	0
Total	63	37	5	102	20	0	335	66	0

cancer statistics is of course determined by the vast preponderance of the late and unfavorable cases.

A more encouraging outlook is obtained from Table III which shows that 5 year cures may be hoped for in over one half of the early and in over one third of the intermediate cases.

The failure of efforts to reduce more materially the percentage of patients who come for treatment in an advanced stage of the disease is a discouraging aspect of the present status of cancer control but the relatively great success being obtained in the treatment of the favorable cases remains a strong incentive to continued striving for earlier diagnosis.

CANCER OF THE CERVIX AND CANCER OF THE BREAST

FIVE YEAR END-RESULTS IN THE UNIVERSITY OF CALIFORNIA HOSPITAL

FRANK W. LYNCH, M.D., F.A.C.S. AND EDWIN I. BARTLETT, M.D., F.A.C.S., SAN FRANCISCO, CALIFORNIA

THIS is a summary of the 5 year cures in a series of 222 cases of proved carcinoma of the cervix treated in the University of California Hospital between March 16 1916, and September 30 1927. No case has been lost in the follow-up since treatment. Seven patients died of intercurrent disease during the 5 year observation and 4 died following surgery. These are charged as cancer deaths.

The cases are grouped into the four stages adopted by the American College of Surgeons.

Stage I. Cancer limited to the cervix.

Stage II. The cancer may have reached one or the other of the vaginal fornices but there is no demonstrable extension to the parametrium. The uterus is still mobile.

Stage III. The cancer has extended beyond the cervix and definitely invaded the parametrium. The uterus is fixed.

Stage IV. The cancer forms a mass which fills the pelvis, may have grown down on the vaginal walls, may or may not have metastasized, and represents the last stages of the disease.

Stage V. Recurrent cases.

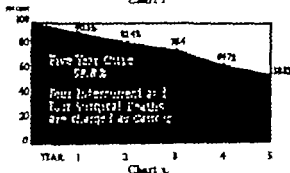
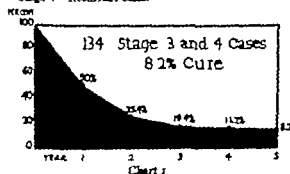


Chart 1. Cancers of uterine cervix.

Chart 2. Percentage of cures found in the various stages.

Type of material. The series comprises 185 cases in which the cancer was first treated by me (Lynch) and of 37 in which a hysterectomy was done by others and radiated subsequently by me either as prophylaxis or as treatment of known recurrence.

Results of treatment. Stage I. Of the 19 cases, 17 are living and well 5 years after treatment. There were two intercurrent deaths charged as cancer. One died from a paralytic stroke 5 months after surgery and 1 of heart disease 4 years after radium treatment. Symptomatic cancer was found in the latter patient at autopsy in both the right and left hypogastric glands. The cure for this group is 89.5 per cent.

Stage II. Of the 32 cases, 13 were living and well at the end of the 5 year observation period, a cure of 40.6 per cent.

Stage III comprises 85 cases with only 11 survivors, a cure of 12.8 per cent.

Stage IV consists of 49 cases. No five year survivors. Forty four of the 49 died within the

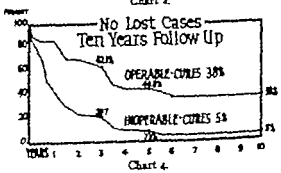
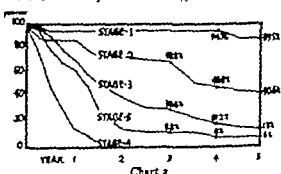


Chart 3. Cancers of the uterine cervix, 51 cases, stages I and 2.

Chart 4. Carcinomas of the cervix, 111 cases.

first year and all but one within a year and 3 months. The extremely large percentage which cures of this stage form of all inoperable cases reduces the total cure of the inoperable cases to figures less than those from other clinics that had learned earlier than we that it is useless to treat them.

Stage V. Of 37 patients of this group 4 were 5 year survivors a percentage of 10.8.

SUMMARY

The 5 year cure for the entire series is 20.3 per cent including those in Stage V or 22.2 per cent for the 185 patients for whose first treatment we were responsible.

Combining the cases in Stages I and II we find 5 year cures of 58.8 per cent for this early and 'borderline as to operability' group.

Combining the 85 Stage III and 49 Stage IV cancers we find a cure of 8.2 per cent.

The entire series consists of 222 treated cases with 45 survivors.

CONCLUSIONS

This study shows that a cure may be confidently expected in early cervical cases following proper treatment.

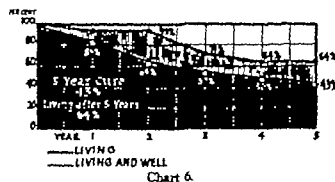
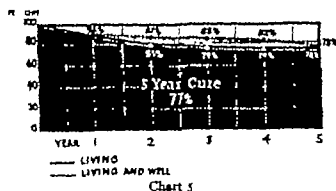


Chart 5. Carcinoma of the breast, Group A1, 39 cases, primary without axillary metastases, local conditions favorable.

Chart 6. Carcinoma of the breast, Group A2, 14 cases, primary without axillary metastases, but with unfavorable local conditions, such as large tumor, tumor in an inner quadrant, etc.

TABLE I—CARCINOMATA OF THE BREAST, 156 CASES

	Cases	Per cent
Group A1	39	
Group A2	14	
Group B1	34	
Group B2	69	
Lost from follow-up	9	
Death—intercurrent	4	
Death—surgical	1	
Death—cancer	81	
Living and well	50	32
Living—recurrence	11	7

CARCINOMA OF THE BREAST

This is a summary of the 5 year results in 156 cases of carcinoma of the male and female breast treated at the University of California Hospital between January 1, 1918 and October 1, 1927. The cases have been placed in four groups, according to prognosis as judged by the operative finding.

Group A1 includes primary cases without axillary metastases and with favorable local conditions such as small tumor, tumor in an outer quadrant, etc.

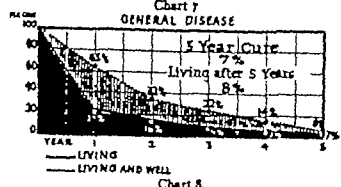
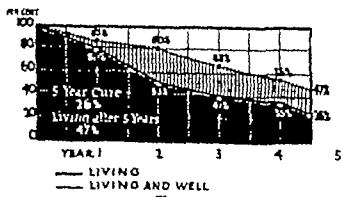


Chart 7. Carcinoma of the breast, Group B1, 34 cases, primary with metastases, local conditions favorable.

Chart 8. Carcinoma of the breast, Group B2, 69 cases, primary carcinoma with metastases and with unfavorable local conditions, extensive involvement, inner half, etc. Recurrent carcinoma, limited involvement, no evidence of general disease.

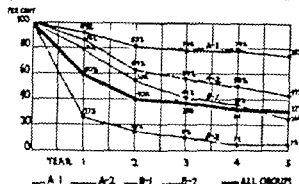


Chart 9. Five year results in 146 cases of carcinoma of breast.

Group A2 includes cases also without axillary metastases, but with unfavorable local conditions, such as large tumor, tumor in an inner quadrant, etc.

Group B1 includes primary cases with axillary metastases but with favorable local conditions.

Group B2 includes also primary cases with axillary metastases but with unfavorable local conditions, and also secondary cases without evidence of general disease or extension of disease externally beyond surgical reach.

Material. The series comprises 93 cases treated by me (Bartlett) and 63 cases treated by several others. All had a radical operation, and all of mine were treated by the method which I have previously described.¹

Results of treatment. Group A1. Of the 39 cases treated, 30 are well after 5 years, thus making 78 per cent cured. Of the 9 charged against cancer death, 3 were lost in the first year, 1 died of bronchopneumonia in the second year

and 1 died of pernicious anemia, without any trace of cancer in the third year after treatment. Four actually died of cancer.

Group A2. Of the 14 cases treated, 6 are well 5 years after treatment, thus making 43 per cent cured. All the deaths were due to cancer. This illustrates the increased mortality from cancer in an inner quadrant.

Group B1. Of the 34 cases treated, 9 are living and well 5 years after treatment, thus making 26 per cent cured. Out of the 25 charged against cancer death, 3 were lost, thus 22 actually died of cancer.

Group B2. Of the 69 cases treated, 5 are living and well 5 years after treatment, thus making 7 per cent cured. Of the 64 charged against cancer death, 3 were lost, 1 died following operation, and 2 died of intercurrent disease, thus making 58 who actually died of cancer.

SUMMARY

There were 5 year cures in 32 per cent of the entire series. The life expectancy in Group A1 (with favorable local conditions and without axillary metastases) is nearly twice as good as that in Group A2 (where the local conditions are unfavorable) and is three times as good as in Group B1 (which had the same favorable local conditions but with axillary metastases). The life expectancy in the groups without metastases (A1 and A2) is double that of B1 alone. If we exclude Group B2 in which the majority of cases gave no hope of cure from the clinical findings alone, the hopeful clinical case with or without metastases should have a 50 per cent chance of cure.

CANCER OF THE CERVIX UTERI

STATISTICAL STUDY OF ONE THOUSAND FIVE HUNDRED AND SEVENTY EIGHT PATIENTS
TREATED AT THE HOWARD A. KELLY HOSPITAL BETWEEN JANUARY 1 1911 AND
SEPTEMBER 30 1927¹

CURTIS F. BURNAM, M.D., F.A.C.S., BALTIMORE, MARYLAND

CANCER of the uterine cervix when treated in its incipency is curable in nearly every case. The possibilities of cure steadily diminish as the disease advances until it becomes an incurable and fatal malady.

A review of the records upon which this paper is based demonstrates that a considerable proportion of the hopeless and far advanced cases are in these stages because of the ignorance and carelessness not only of the patient, but frequently of her medical advisers.

While the methods of employing existing means of treatment are steadily being improved it is evident that more can be gained in treating this disease by education which will bring patients in for treatment during the earlier stages of the cancer. At this writing about 50 per cent of the cases which present themselves for treatment at The Johns Hopkins Hospital are operable but only a very small proportion of these are in the very early stage in which the disease is limited to the cervix.

In order to study the results obtained by treatment of the 1578 cases which presented themselves in the period between January 1 1911 and October 1 1927 they have been grouped under five distinct headings: operable, prophylactic, inoperable, recurrent and palliative.

At this hospital the principal method of treatment has been by radium and secondarily by surgery and X-ray. The relatively small percentage of operable cases is due to the fact that the sources from which these cases came during these years, principally relied on surgical methods alone in the treatment of the operable cases coming to them. Slightly over 13 per cent of all cases treated have been early enough to be classified as operable.

In addition to the anatomical extent of the disease the results are dependent upon technique employed in treating and upon the type and grade of malignancy found on microscopical examination. Time does not permit, however, of a consideration of the influence of these factors upon the 5 year cure rate.

Let us now consider the five headings under which our cases are grouped:

Operable cases. Under this caption are included all the stages except those presenting firm fixation through the parametrial and paravaginal tissues to the pelvic wall and those with definite palpable glandular metastases. It comprises not only the operable but borderline cases. It includes the vaginal extensions no matter how extensive and the parametrial involvements which do not extend as far as firm fixation to the pelvic wall. All of these cases are cases treated with radium or radium and X-ray.

Prophylactic cases. These cases represent the same extent of trouble or perhaps a little less than in the first group. They are differentiated because they were first treated by surgical removal and then by postoperative radiation.

Inoperable cases. Under this caption are included all those cases which present firm fixation to either one or both pelvic walls through the parametrial or paravaginal tissues. Most of these patients presented extensive vaginal extensions of the disease. Excluded from this group are cases with general or with demonstrable extensive local glandular involvement.

Recurrent cases. Under this title are included all recurrences which have followed the surgical removal of the uterus for cancer of the cervix. In these cases the extent of the disease present at the time of treatment varied greatly.

Palliative cases. Under this caption are placed all cases showing general metastases or extensive local glandular metastases. Most of them have been associated with massive local fixation. The treatment given has been not to cure but to stop bleeding or to alleviate pain.

THE RESULTS OF TREATMENT

In Table I is shown by years, the total number of cases treated, the total number of cures and the percentage of cures for cases treated and then the total group is divided into the five divisions indicated and for each group the number of cases, the number of cures and the percentage of cures are shown. This table refers to 5 year cures. No case is included except when 5 full years have elapsed from the time of treatment and when most careful clinical examination demonstrates no

¹These cases were all treated by Howard A. Kelly, William Neill, and the author at The Howard A. Kelly Hospital, and most of them have been seen by at least two of us.

TABLE I.—DISTRIBUTION OF CASES FROM JANUARY 1, 1911 TO OCTOBER 1, 1927

Total Number of Five Year Cases and Percentages in the Different Groups

	Total Cases	Cured cases No.	Cured %	Operable cases No.	Operable %	Prophylactic cases No.	Prophylactic %	Inoperable cases No.	Inoperable %	Recurrent cases No.	Recurrent %	Palliative cases No.
1911	12	3	25	100				4	33	5	42	
1912		30	100	100						4		
1913	34	26	76	100						18		0
1914	46	26	56	100				8	17	4	9	5
1915	83	6	7	11	13	100		42	50	4	5	3
1916	109	3	3	100				17	15	40		4
1917	79	3	4	100				16	20	4	5	6
1918	70	3	4	100				23	33	10	14	3
1919	98	26	26	100				42	43	10	10	2
1920	80	1	1	100				20	25	33	41	
1921	10	9	90	100				2	20	6	60	
1922	84	4	5	100				37	44	7	8	
1923	7	7	100	100				9	128	9	128	4
1924	3	2	66	100				2	66	6	200	6
1925	12	12	100	100				30	250	7	58	
1926	2	2	100	100				1	50	6	300	6
1927	84	79	94	100				17	20	1	1	9
	373	23	6	100				100	270	27	7	10

trace of the disease. The cases of patients dying from other causes than cancer as well as all the cases of patients who have not been traced are placed in the uncured class. In our entire series, there are 41 cases in which a clinical cure was known to be present for several years, but, as yet, we have been unable to trace the patients and make sure of the final result. Of these 41 cases 17 were inoperable, 9 were operable, 5 were recurrent, and 5 prophylactic. The variations in percentages of cures depend in part, on the distribution as to extent of disease in part, perhaps on the varying techniques employed and, in part, on the types and grades of malignancy. It beautifully demonstrates, however the limitations

TABLE II.—COMBINATION OF ENTIRE 1578 CASES SHOWN IN TABLE I

	Cases	Cured	Per cent
Cured		258	16.36
Operable	145	81	55.79
Prophylactic	60	15	25.00
Inoperable	969	11	1.13
Recurrent	302	34	11.25
Palliative	90		

Percentage of frequencies of cases in the five groups

	Per cent
Operable	9.37
Prophylactic	3.60
Inoperable	61.40
Recurrent	19.13
Palliative	6.47

Ten year results on cases treated prior to October 1, 1922.

Total number of 5 year cured cases	150
Living and well at end of 10 years	110
Dying of recurrence from sixth to tenth year	16
Dying of other forms of cancer from sixth to tenth year	3
Dying of other disease	6
Followed for 7 years or longer and now being investigated	15

The oldest cured cases 3 well for 21 years—2 of them extensive borderline, and 1 extensive recurrence.

which must be put on drawing deductions from a small series of cases, such as is presented by any one year.

In Table II are shown the combined results of the entire series of cases, as well as the results obtained in each of the five groups for the 5 year period. In addition, the relative percentage frequencies of each of the five groups is shown, and also the 10 year results on the cases which were well at the end of 5 years. Finally the results are given in the cases treated in 1911 which was the first year of this series.

While 5 years is an arbitrarily accepted standard for a cure, it must be constantly kept in mind that recurrences may take place after this period. However it is of interest that we have had only one recurrence after 10 years, and this might be interpreted as a primary new-growth, as it occurred in the lungs. Taking the period prior to October 1, 1922 there were 150 5 year cure cases. At the end of 10 years only 110 were still living and well as shown by examination. Of the 40 cases remaining 16 died of recurrence between the sixth and tenth year 3 died of cancers of a different type developing *ad novo*. It may be of interest here to mention 2 cases, in 1 of which the patient was cured of a cervical cancer for 10 years, and is now cured of a breast cancer for 4 years the second was cured of a cervical cancer for 6 years, and of an uterine cancer for 3 years.

Fifteen patients who were traced from periods varying from 7 to 10 years, have been temporarily lost sight of. Six cases after the 5 year period died of other causes than cancer.

It is of interest that the 3 cured cases of the year 1911, 21 years ago are all still well. Two were extensive borderline operable cases and one an extensive recurrent case.

CANCER OF THE PELVIC ORGANS

W. E. CALDWELL, M.D. F.A.C.S., NEW YORK

THE experience of a general hospital with a gynecological service would seem to be instructive. In the Sloane Hospital up to 1929 cancer of the female reproductive organs was treated as part of the regular routine service. Those requiring operative treatment were skillfully handled. Those requiring other forms of treatment radiotherapeutic electrical and heat, were handled according to the intensity with which the particular therapist happened to have studied that particular field. In cancer of the cervix experience with radium is of interest. The follow up studies show a 5 year cure in 7 cases of 21 or 33 1/2 per cent of those in which the process was limited to the uterus but in those in which the process had spread to the vagina or broad ligaments in only 16 cases of 94 or 6 per cent. (All patients not followed are classed as dead.) In reviewing the dosage of radium, the greatest variety is seen varying from one barely sufficient to produce an artificial menopause to one which according to present standards would be considered adequate. Similarly the study of the follow up statistics of these cases shows a great unsatisfactory variation. Those physicians who were interested obtained results far superior to those who treated women merely as a part of the routine.

In 1929 a group was organized within the Department of Obstetrics and Gynecology composed of two members of the staff who co-operate with the Department of Pathology and the Department of Radiotherapy. Into their hands was placed the responsibility for all radium treat-

ment and the pre-operative and postoperative conduct of the cases. Since this time the operative treatment has gone on as before. The efficacy of the radium treatment on the other hand as indicated by the 3 year results has advanced greatly and the follow up clinic shows a return of 95 per cent.

The moral from this experience is that the treatment of a disease such as cancer of insidious onset and prolonged course whether favorable or unfavorable requires an interested group equipped to carry out any diagnostic procedure or any therapy, and organized to maintain constant contact with a cancer patient from the time such a condition is suspected. Whether this group should function as a subgroup under one of the therapeutic specialties as radiotherapeutics or of a cancer clinic or on the other hand as a subgroup of the gynecological department is a matter of debate. In this disease it is felt that above all else early diagnosis is important and that by having the gynecological cancer cases diagnosed and followed in the gynecological clinic, the losses caused by the referring of the patient from one department to another will be minimized and the patients brought earlier to treatment. Moreover the treatments themselves are within limits fairly well standardized. Operative techniques have varied very little for many years. The use of radium as developed in different centers in many parts of the world has gradually worked out so that the principles of the techniques are fundamentally the same and the results in large groups show unimportant variations.

RESULTS OF TREATMENT OF CANCER OF THE UTERUS AT THE MASSACHUSETTS GENERAL HOSPITAL

LINCOLN DAVIS, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

I AM glad to take part in a symposium on cases of cured cancer for I am sure that in spite of all the good work done by various organizations in spreading a note of hopefulness in the treatment of cancer there is still a very widespread feeling that the disease is hopeless and incurable. This feeling exists not only among the laity but also with many general practitioners. Each of the latter sees relatively few cases in his own practice, and if there happen to be a consecutive number of bad results naturally the practitioner becomes pessimistic about the situation. If large series of cases are analyzed however it is found that there is a very respectable percentage of arrests of the disease or cures.

With the laity the situation is even worse. The average person is fond of talking about his or her operation but I have never heard any one talk about having had an operation for cancer. As a matter of fact the patient is usually entirely unaware of the existence of the disease in his own case, the secret having been carefully guarded by the doctor as well as by relatives and friends. This was forcefully brought home to me a number of years ago when in talking with a friend, a very intelligent man and a prominent attorney I told him that I had been giving a talk on cancer. He said, "As a matter of fact, has a case of cancer ever been cured?" This man himself had been operated on some 15 years previously for cancer of the sigmoid flexure, by the late John W. Elliott of Boston, who performed an entirely successful removal with suture of the bowel. However this highly intelligent and generally well informed man was entirely unaware of the fact that he himself represented a cure of a very malignant form of cancer of the bowel. On the other hand when a patient succumbs after an operation or following a long illness it is quite generally circulated that "poor so and so had cancer." So that the brilliant results are carefully hidden while the fatal cases are thoroughly discussed. Therefore I think the American College of Surgeons is to be thoroughly commended for persistently keeping this aspect of the subject before the profession and the public.

I am convinced that a large number of cases of cancer have been cured in the past, a still larger number are being cured at the present time and even greater prospects lie before us in the future.

I wish to present a brief report of the results of treatment of cancer of the uterus at the Massachusetts General Hospital. These results may not seem brilliant, the figures are not perhaps as large as one might expect but it should be remembered that this is a general hospital specializing in no way in gynecology. In fact for several years following the year 1922 when it began to become evident that the results of radium treatment of cancer of the cervix were at least as good if not better than the results following radical operation patients with this disease at the General Hospital were as a rule referred to other institutions for treatment, as the Massachusetts General at that time had no radium. It was not until the year 1925 that radium treatment of cancer of the cervix was begun on a very small scale, so that the opportunities for reporting 5 year "cures" following its use are extremely limited. Nevertheless, the results have been distinctly heartening, encouraging us to continue and increase its use with substantial abandonment of hysterectomy. The next few years will show whether or not our confidence has been well founded.

The standard of cure generally adopted in compiling cancer statistics, the so called 5 year cure, consists of an observation period of 5 years following treatment, at the end of which time the patient is living without discoverable signs of the disease. This standard has been followed in this report but it should, of course, be understood that the term is used in a relative rather than an absolute sense, and that the period of 5 years merely represents a lapse of time which indicates that future recurrence is relatively unlikely. Recurrences are most frequent in the first 2 years after treatment, and progressively diminish thereafter. Three years has been proved an insufficient period of observation. Recurrences, unfortunately do take place after 5 years or even after 10 or 20 years, or at any period.

In this report 4 patients, who have been included among the cured cases, having been reported living and well at the end of 5 years, died of undoubted recurrence at the end of 6, 7, 8, and 15 years, respectively. On the other hand, 8 patients reported well by letter at the end of 5 years who died of abdominal metastases early in the sixth year are not included. If an absolute cri-

tion of cure were demanded it would be necessary to establish the freedom of the body from recurrence by a complete autopsy after the death of the individual an obvious absurdity.

Interest in the operative treatment of cancer of the cervix at the Massachusetts General Hospital started in 1901 when Dr Farrar Cobb began doing a modified Wertheim operation. He later was given the assignment of all cases in the hospital. In 1920¹ Dr Cobb made a report of his results with the radical operation showing 5 year cures in 11 of 26 cases, or 42 per cent.

In 1915 the assignment of the operative treatment of cancer of the cervix came into my hands. I reported before the American Surgical Association in 1922² the end results of my work with the radical operation showing 8 cases of survival of 5 years or more without recurrence in 20 cases followed up or 40 per cent.

In 1925 as before stated we began the use of radium at the hospital in a small way at first only for the advanced cases of carcinoma of the cervix. Gradually however radium supplanted radical operation in the treatment of the more favorable cases and only two radical Wertheim hysterectomies have been done since 1925.

I have personally performed a total of 43 hysterectomies for cancer of the cervix at the General Hospital. Four of these patients have not been traced. Of these 43 proved cancer cases 16 patients survived the operation for 5 years without signs of recurrence or 37 per cent. Two patients have survived for 16 years and are in good health today. One of these showed definite invasion of the parametrial tissue removed.

The radium cases are limited in number and comprise 11 cases of 5 year cures. The earliest of these was treated in July 1925. There were 2 cases in which radical hysterectomy was preceded by radium treatment. One of these resulted in a cure which has been credited perhaps somewhat arbitrarily to the hysterectomy.

In estimating the value of any form of treatment it is important to know what proportion the successful cases bear to the whole number seen or treated. In 1925 there were 15 cases of carcinoma of the cervix treated with radium with 5 cases of 5 year cures. In 1926 there were 24 cases treated with 2 cases of 5 year cures. In 1927 up to September there were 25 cases with 4 cases of 5 year cures. Altogether 64 cases were treated with radium with 11 cases of 5 year cures or 17 per cent. There was no selection of cases only the moribund were excluded.

An analysis of the records of patients operated upon by me personally shows that something over 30 per cent of all cases seen were subjected to radical operation. A percentage that was perhaps unduly high for the best operative results. In the 42 radical abdominal hysterectomies and 1 vaginal hysterectomy there were 4 operative deaths a mortality of 9.5 per cent. There has been no mortality in the cases treated with radium.

Cases of adenocarcinoma of the body of the uterus have been treated by hysterectomy as a first choice radium being used only if distinct contra indication to a major operation existed. In carcinoma of the body of the uterus as contrasted with carcinoma of the cervix the operability rate is relatively high and the mortality rate relatively low. Furthermore the disease is of relatively slow growth metastasizing outside the uterus at a late stage so that the total abdominal operation gives exceedingly good results superior in our hands to the application of radium which involves some danger of perforation or hemorrhage and at best is a blind procedure.

In an analysis of 50 cases of adenocarcinoma of the body of the uterus at the Massachusetts General Hospital made in 1925³ I found over 60 per cent of 5 year cures. This compares favorably with the results of the treatment of cancer anywhere in the body excepting only superficial lesions of the skin.

During the past year Dr J V Meigs has undertaken an intensive follow up study of all the cases of cancer of the uterus at the hospital during the last 20 years, checking up and reviewing the pathological specimens and throwing out all doubtful cases and all cases in which the pathological specimens have been lost, also personally examining surviving patients. A few cases recorded as cures in previous reports have been excluded in this rigid review. The follow up has not yet been completed and it is fair to expect that some additional cures will be found. I am greatly indebted to Dr Meigs for the use of his data.

As a result of this review to date it is found that there are at the Massachusetts General Hospital complete records of 64 women who had microscopically proved cancer of the uterus who have survived treatment for at least 5 years without signs of recurrence so called 5 year cures. Of these patients 34 had carcinoma of the cervix, and of these 23 had radical hysterectomies and 11 were treated with radium. Thirty patients had carcinoma of the body of the uterus of these 28 were treated by hysterectomy either vaginal

or abdominal, and 2 were treated with radium. Slightly over one-half of these cases were personal

ones, the others were treated by colleagues on the hospital staff

GYNECOLOGICAL CANCER

W. A. G. BAULD M.D. F.A.C.S., MONTREAL, CANADA

ON the plen of this College to establish a faith in the curability of cancer in the minds of the medical profession and the public in general, I come to add a contribution from the Royal Victoria Montreal Maternity Hospital Montreal Canada

The figures I regret are small but represent the first series available over the prescribed 5 year period. The percentage cured and remaining well in this series is 26.6 (4 out of 15)

The care of the cancer patient applying to a large gynecological clinic offers peculiar and special difficulties. We have all seen the sacrifices to inexperienced treatment—the fatal delay in the undiagnosed case—the careless patient who does not follow advice and must be searched out and driven in when delinquent and who will return only on the appearance of urgent and late symptoms. We all know the neglected and pitiful state of the dying cancer patient and we all know how easily they fall prey to the designs of unscrupulous cancer cure schemes. They require guidance and protection as well as treatment and comfort.

While all will admit the benefits accruing from large and specialized cancer clinics with every facility for treatment and research it is not yet possible for these institutions to reach all the sufferers first hand and frequently the best chance is lost through inexperienced and damaging or incomplete treatment.

There remain of necessity a great number of patients who must be treated in the clinics of their vicinity and it was these factors which stimulated the formation of a subdivision of our main gynecological department under what is known as the Cancer Clinic and from which these results come

A few words of the formation and activities of this unit I think, may be of some assistance to those similarly situated. The immediate direction of the unit was placed under one member of the

existing general staff trained and practicing gynecology in all its branches. He was required to make a special study of gynecological cancer in all its phases and the most efficient methods of treatment—needless to say this implied a study of radium and other radiological methods and their appropriate uses. To the group was added a second member of the staff with special training in laboratory methods and pathology so bringing this important factor into intimate interest with the problems. This move has proved extremely valuable in the clinical work.

An adequate supply of radium was provided for the work and the care and use of the radium is entrusted to the members of this subgroup this I believe important to insure the safe and proper use of radium when required for cases other than cancer

Accessible X-ray facilities are available through the main hospital X-ray department but with an increased growth of the clinic it is evident that suitable and special apparatus may be advantageously placed near the special clinic.

Records and follow up comprise a most important branch of the work and requires unusual interest and fidelity to the work. I am happy to tell you that this work has been well done and that only 8 of a total of 228 during the activities of the clinic have escaped observation over a period of 6 years.

In conclusion may I emphasize the following points

1. Cancer patients applying to a gynecological clinic should be segregated into a special clinic.

2. This clinic should be under the direction of a clinician who has special knowledge and experience in radiological methods.

3. Special records and an accurate follow-up are vital to results.

4. Results may be obtained equal to the larger and more favorably equipped special cancer clinics.

CANCER OF THE BREAST

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WHEN a woman consults a surgeon for a lump in her breast, one question and one only of paramount importance at once presents itself to the surgeon for answer namely Is this lump cancer or is it not? All other questions but this can await an answer. This one cannot, and until it has been answered beyond all question of doubt, the first duty of the surgeon to his patient will not have been discharged. As soon as the diagnosis of malignancy has been definitely determined the combined judgment of experienced surgeons and pathologists demands the immediate removal *en masse* by surgical operation of the entire breast and all adjacent structures that may possibly be invaded by the growth. Until complete extirpation with a wide margin by clean dissection of all suspicious tissues has been accomplished the second great obligation of the surgeon to the patient with cancer of the breast will not have been discharged. In the present state of our knowledge there can be no possible excuse for failure to recognize cancer of the breast or to apply promptly the only effectual remedy namely its radical removal as described by Halsted in his epoch making communication in 1894.

That cancer of the breast as elsewhere is curable and that cancer of certain types and in certain regions of the body is more amenable to treatment than in others are established facts. Because it is not a vital organ and owing to its anatomical structure the breast lends itself readily to thorough examination and complete removal. The one thing yet lacking in securing the maximum number of cures is the active intelligent co-operation of the patient. She must, somehow be impressed with the absolute necessity of consulting her physician at the first sign of any trouble in the breast. This is the crux of the whole matter.

My contribution to this discussion is based upon a study recently made by Lewis and Rieholf of 950 consecutive cases of cancer of the breast many of them my own operated upon in the Johns Hopkins Hospital over a period of 42 years from the beginning of the hospital in 1889 to 1931 by 38 different surgeons. Of this number 517 cases operated upon more than 5 years have been traced and their present condition is known. Of this number 135 (26 per cent) lived from 5 to 32 years following operation. While this percentage of cures compares favorably with other statistical studies it must not be forgotten that over 50 per cent of the cases were operated upon by members of the resident staff and that the period covered runs back to the very beginning of the Halsted operation when cases were very late in coming to operation.

The recital of these results will at once suggest to the mind of every thoughtful surgeon two ideas (1) how comparatively small is the number of cures obtained and (2) the query. By what means may this number be materially increased?

Four significant facts emerge from a symposium such as this (1) That cancer is curable or what amounts almost to the same thing it may be held in abeyance for an indefinite term of years by timely radical surgical measures (2) That early diagnosis is essential to success. (3) That the most radical excision of the growth is alone productive of the best results. (4) That in the present state of our knowledge any improvement in our percentage of cures must come through educating the patient to seek earlier advice. The physician is not always blameless in failing to refer his patient at once to a competent surgeon and the surgeon himself is not always sufficiently radical in his removal of tissues to give the patient her best chance. In all three of these directions improvement may be made.

CARCINOMA OF THE CERVIX UTERI

COMBINED STATISTICS OF PATIENTS TREATED IN THE CANCER CLINIC OF THE WOMAN'S HOSPITAL IN NEW YORK SERIES FROM 1919-1927 WITH A FIVE YEAR OBSERVATION PERIOD

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WE have previously published statistical reports of the 5 year results we have obtained with radiotherapy of carcinoma of the cervix uteri at the Woman's Hospital in 1925, 1928 and 1930. We now have two more 5 year series to report making 6 series in all covering a period of thirteen years.

During this time I have had under my direction some 500 odd cases of cancer of the cervix and more than 100 cases of carcinoma of the fundus. There are 3 cases of the cervix in which the 5 year observation period has been completed and this group forms the basis for this statistical report.

The important features of our technique as previously published are a personal follow up each month of all cases throughout the 5 year period as far as is possible, the employment of blood transfusions before or shortly following radiotherapy in all anemic or cachectic patients, and the re-irradiation of metastatic recurrences in the vaginal tract in their incipency when discovered in the follow up clinic. Our initial dosage averages from 3,600 to 4,200 milligram hours of radium element.

The results recorded in this report include 98 cases of the last two 5 year series from May 15, 1925 to May 15, 1927. The complete statistics of the 5 year end-results of all cases of carcinoma of the cervix uteri treated at the Woman's Hospital from February 25, 1919 to May 15, 1927 or a total of eight series, is shown in the following tables. This includes the 14 patients who were refused radium treatment because the growth was too far advanced.

TABLE I.—CASES OF CARCINOMA OF CERVIX SUITABLE FOR RADIUM THERAPY

	Number	Per cent of total
Total cases seen	357	100.0
Cases treated with radium	343	96.1
Cases refused radium	14	3.9
Radium operability—96.1 per cent		

Table II shows that 21.6 per cent of the total number of cases were operable (limited to the cervix) whereas 8.4 per cent were inoperable (extended beyond the cervix).

TABLE II.—OPERABILITY IN CASES OF CARCINOMA OF CERVIX

	Number	Per cent of total
Total	357	100.0
Operable—limited to cervix	77	21.6
Class I Schmitz	4	1.1
Class II Schmitz	73	20.5
Inoperable—extended beyond cervix	280	78.4
Class III Schmitz Stages II & III	240	67.2
Class IV Schmitz Stage IV	40	11.2

TABLE III.—AGES OF CARCINOMA OF CERVIX PATIENTS

Years	Number	Per cent of total
30 to 40 years	18	5.0
30 to 39	71	19.9
40 to 49	121	33.9
50 to 59	94	26.3
60 to 69	40	11.2
70 to 79	12	3.4
80 to 89	1	.3
	357	100.0

Youngest 14 years

Oldest 80 years

Five per cent of the patients were under 30 years of age

TABLE IV.—PRIMARY MORTALITY OF RADIUM TREATMENT FOR CARCINOMA OF CERVIX

	Radium applications	Deaths per 100 applications	Deaths per case
Total	597	6	1.1
Class I Schmitz	3	0	0
Class II Schmitz	125	0	0
Class III Schmitz Stages II & III	409	3	.7
Class IV Schmitz Stage IV	27	3	11.1

The primary mortality for all cases treated was 1.1 per cent with no deaths in the Class I or Class II (Schmitz Class) (League Nations Stage I cases).

TABLE V.—CARCINOMA OF CERVIX FOLLOWING SUPRAVAGINAL HYSTERECTOMY

Derived from total of 357 cases

Number	19
Living 5 years	8
Per cent	42.17

TABLE VI—FIVE YEAR END-RESULTS IN CASES TREATED FOR CARCINOMA OF CERVIX

Grouped according to Schmitz Classification of Extent of Disease

Class	Number	Living	Per cent living 5 years
I	4	2	50.0
II	73	36	49.3
III	240	47	19.6
IV	17	0	0
Total	343	85	24.8

TABLE VII—FIVE YEAR END-RESULTS IN PATIENTS TREATED FOR CARCINOMA OF CERVIX

Grouped according to League of Nations Classification of Extent of Disease

Stage	Number	Living	Per cent living 5 years
I	77	38	49.4
II	131	33	25.2
III	118	14	11.9
IV	17	0	0
Total	343	85	24.8

Table VII shows that 49.4 per cent of the cases falling into the League of Nations Stage I were saved for at least 5 years. 25.2 per cent of the Stage II cases received 5 year cures. 11.9 per cent of the Stage III cases lived for 5 years after the first radium treatment. None of the Stage IV cases survived the 5 year period.

TABLE VIII—FIVE YEAR END-RESULTS IN PATIENTS TREATED FOR CARCINOMA OF CERVIX
Comparison between League of Nations and Schmitz Classifications

League of Nations Classification	Schmitz	Number	Living	Per cent living 5 years
I	I & II	7	38	49.4
II & III	III	240	47	19.6
IV	IV	17	0	0

TABLE IX—FIVE YEAR END-RESULTS IN CARCINOMA OF CERVIX TREATED BY UNIFORM WOMAN'S HOSPITAL RADIUM TECHNIQUE

Does not include patients with previous or subsequent treatment or operation elsewhere or patients treated previous to May 1920 when method was unstandardized

	Number treated	Living	Per cent living 5 years
Total	255	61	24.3
Classes I and II Schmitz Stage I L.N. Limited to cervix	46	24	52.2
Classes III & IV Schmitz Stages III, III, IV L.N. Extended beyond cervix	209	37	17.7

Hospital technique 18.2 per cent of the Class III and IV Schmitz (League of Nations Stages II, III and IV), the inoperable patients were saved for 5 years or more.

TABLE X—FINAL SUMMARY OF FIVE YEAR END-RESULTS IN PATIENTS WITH CARCINOMA OF CERVIX

	Living	Per cent living 5 years
Total seen	357	23.8 "absolute cure"
Total treated	343	24.8 "relative cure"

Errors cases were lost in the follow-up and have been provided as dead of cancer.
Completed follow-up—0 per cent

TABLE XI—CARCINOMA OF CERVIX UTERI TREATED BY WOMAN'S HOSPITAL TECHNIQUE MAY 1920—MAY 15, 1927 GROUPED ACCORDING TO CELL TYPE

	Number	Per cent of total
Total treated	262	100.0
Squamous I	58	22.1
Squamous I and II	25	9.5
Squamous II	0	0.0
Squamous II and III	10	3.8
Squamous III	24	9.2
Squamous I and III	10	3.8
Adenocarcinoma	22	8.4
Adenocarcinoma and squamous	1	0.4
Unclassified	33	12.6

An attempt has been made as seen in Table XI, to group the cases of carcinoma of the cervix according to the type of cancer cell found on microscopical examination. In this series 91 per cent were epidermoid or squamous cell type.

TABLE XII—FIVE YEAR END RESULTS IN CARCINOMA OF THE CERVIX UTERI TREATED BY THE WOMAN'S HOSPITAL TECHNIQUE MAY 1920—MAY 15 1927 GROUPED ACCORDING TO CELL TYPE

	Number	Living	Per cent living 5 years
Total treated	262	65	24.8
Squamous I	58	17	29.3
Squamous I and II	25	3	12.0
Squamous II	70	24	34.3
Squamous II and III	10	0	0.0
Squamous III	24	5	20.8
Squamous I and III	10	0	0.0
Adenocarcinoma	22	8	36.4
Adenocarcinoma and squamous II	1	1	100.0
Unclassified	33	9	27.3

*Relative cure rate.

From Table IX one notes that 52.2 per cent of the Class I and II (League Nations Stage I) early cases are salvaged for 5 years by the Woman's

The highest cure rate for any one is 36.4 per cent for the adenocarcinoma. In this group 8 of the 22 patients at least 5 years. This finding is con-

TABLE XIII—FIVE YEAR END-RESULTS OF CASES OF CARCINOMA OF THE CERVIX UTERI TREATED AT WOMAN'S HOSPITAL, MAY, 1920—MAY 15, 1927, WOMAN'S HOSPITAL TECHNIQUE, GROUPED ACCORDING TO CELL TYPE AND EXTENT OF DISEASE (SCHMITZ CLASS)

	Class I Schmitz	Class II Schmitz	Class III Schmitz	Class IV Schmitz	Total cases
Squamous	2 of 2	64 of 73	21 of 23	0 of 0	87 of 96
Squamous I and II	No cases	23 of 24	10 of 9	0 of 0	33 of 33
Squamous II	0 of 0	14 of 15	20 of 27	0 of 0	34 of 42
Squamous II and III	No cases	0 of 0			
Squamous III	0 cases	0 of 0	3 of 3	0 of 0	3 of 3
Squamous I and III	No cases	No cases	0 of 0	0 of 0	0 of 0
Adenocarcinoma	No cases	71 of 7	1 of 1	0 of 1	72 of 9
Adenocarcinoma and squamous II	No cases	No cases	100 of 0	No cases	100 of 0
Reclassified	No cases	15 of 3	6 of 17	0 of 1	21 of 21
Total cases	20 of 20	83 of 80	30 of 40	0 of 1	93 of 141

general belief that adenocarcinomata of the cervix are more difficult to cure than the squamous cell carcinomata. The next best cure rate was 34.3 per cent for the squamous II type, and thirdly came the squamous I type with a 5 year cure rate of 29.3 per cent. Only 3 of the 24 patients, or 12.5 per cent of those showing squamous III cells survived for 5 years. It is interesting to note the exceptionally low cure rates for those cases which showed a combination of two types of cells. Only 12 per cent of the squamous I and II, none of the squamous II and III, and none of the squamous I and III types lived for 5 years. The 5 year cure rate for the unclassified group was 26.4 per cent. This is approximately what one would expect since it is almost the same percentage as the rate of cure for all cases.

Cure rate for all cases. 24.8 per cent
Cure rate for unclassified group 26.4 per cent

There were 33 cases in the unclassified group out of which 9 lived for 5 years or more. In 3 of these 9 cases the specimen obtained was too small to examine. One specimen was lost, 2 specimens were so atypical that no diagnosis could be rendered and in 3 cases no biopsies were taken.

Table XIII was made in an attempt to show the relation of cell type extent of disease, and its bearing upon prognosis. While the groups are very small and general statements are hard to substantiate, nevertheless it can be said that the more extensive the disease and the more malig-

nant and radioresistant the cell type, the worse the prognosis. Adenocarcinoma of the cervix, in this series, gave the best results and therefore the best prognosis. Of the squamous cell carcinomata the squamous II type affords the best prognosis, squamous I affords the next best prognosis, and squamous III gives the worst prognosis. Also, one sees that the further advanced the lesion has extended the worse the prognosis. Class I and II have a considerably better prognosis than Class II and IV.

SUMMARY

During thirteen years at the Woman's Hospital we have demonstrated that in a gynecological clinic with approximately 280 milligrams of radium element, nearly 25 per cent of those treated for carcinoma of the cervix can be saved for a period of 5 years or longer.

We believe that careful preparation and after care of these patients, with a meticulous personal follow-up clinic, and the employment of re-radiations for early manifestations of recurrence in the vaginal tract will materially increase the percentage of patients salvaged for five years.

A 50 per cent or better absolute cure rate with no radium mortality should be attainable in patients with the disease in its early stages.

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FIVE YEAR "CURES" IN CANCER OF THE BREAST

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THE object of this meeting is to present to the medical profession and the public, concrete facts dealing with the cures of patients who have been treated for various forms of cancer. It is highly desirable that we, as medical men, should stress the optimistic side of the cancer problem. The public at large, and many doctors, apparently believe that no case of cancer is ever cured. With such a pessimistic attitude of mind nothing can be achieved in any field of human endeavor, and there is no affliction to which mankind is subject where pessimism is more disastrous or optimism more useful, than in cancer. I feel that it is unfortunate that cancer has been referred to as the great scourge for it is just as respectable a disease as any other disease with which I am familiar and many patients treated correctly are cured of their ills permanently.

I have been asked to present to you a brief statement concerning the absolute number of 5 year cures at The Memorial Hospital for Cancer and Allied Diseases in patients treated for cancer of the breast by radical surgery combined with pre-operative and postoperative irradiation. I have been told that percentage figures are not desired but that the absolute number of 5 year cancer cures in my own experience should be given. I have under personal supervision at the present time 90 patients who were operated on for cancer of the breast 5 or

more years ago. In all of these patients histological verification of the diagnosis of cancer was obtained and today they are entirely free from disease and constitute healthy, useful happy members of the society in which they find themselves. Several patients whom I have followed for still longer periods see me annually for a follow up visit always terming this yearly call our 'anniversary'.

I feel certain that this group of 90 women is as useful and happy as any other 90 individuals you can meet in perfect health. But how has this been accomplished? These women came for treatment at an early stage of the disease when one could reasonably hope for a complete cure of their ailment by a combination of surgery and irradiation.

The main reason why all of us do not have still larger numbers of these 5 year cured patients is because many women will persist in not consulting a doctor at frequent intervals, and will not adopt the plan of a careful complete physical examination by their doctor every 6 months. Moreover they will not seek the advice of a physician the moment any abnormal symptom referable to the breast appears. The other equally potent reason why more women are not permitted to enjoy this same state of a 5 year cure is that not infrequently doctors in their lack of wisdom assure patients that painless lumps in the breast are of no importance and have no serious import.

CARCINOMA OF THE BREAST

SURGICAL TREATMENT AND RESULTS FIVE, TEN AND FIFTEEN YEARS AFTER RADICAL AMPUTATION

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THE surgical treatment of carcinoma of the mammary gland is based on the hypothesis that malignancy is localized at the onset and later in the course of the disease involves other tissues by way of the lymph, and occasionally the blood stream. If this conception of the disease is correct, it is manifest that the most important considerations in treatment are early recognition and immediate complete removal of the growth. The most important factors which influence the results of surgical treatment are the extent of the involvement at the time of operation, the thoroughness with which radical operation is done, and the degree of malignancy as shown by microscopic examination. The following surgical statistics and results of operation are based on a series of 257 cases in which operation was performed between 1910 and 1927 inclusive; this permits the compilation of results over a period of 5 years in all cases.

Recognition of malignant disease of the breast by clinical signs and symptoms depends on the duration of the lesion at the time of examination; these signs and symptoms are hopelessly inadequate in determining early malignant disease. If sufficient time is permitted to elapse, it is probable that 100 per cent of these conditions could be diagnosed clinically, but meanwhile much valuable time has been lost before treatment is instituted, and in most instances the patient will have lost any possibility of obtaining permanent cure from surgical treatment.

Fixation of the skin over the tumor is the most characteristic clinical sign of malignant disease; it was noted in 82 per cent of cases. In studying this group with reference to the presence or absence of lymphatic involvement, it was found that in 72 per cent there was metastasis to the regional lymph nodes, which indicates that if fixation of the skin has occurred, metastasis will have occurred in approximately three fourths of the cases.

Malignant growths are rarely painful in the early stages of the disease, which is one of the chief reasons why patients with malignant disease in all stations of life, delay examination. In many instances they do not come for treatment until the lesion has ulcerated, as was shown in 7.9 per

cent of cases of ulcerated lesions operated on in 1930. This high percentage of cases in which an ulcerating lesion was present at the time of operation again emphasizes the fact that the patients are being seen late in the course of the disease, and also emphasizes the necessity of more earnest educational propaganda.

I do not believe that the presence or absence of metastasis to lymph nodes can be definitely ascertained on clinical examination in all cases. In the cases observed in the last year palpable nodes were found in 60 per cent and in 68 per cent of this 60 per cent definite axillary metastasis was found at the time of operation. In the remaining cases the enlarged nodes were found to be inflammatory. In the 40 per cent of cases in which enlargement of axillary nodes was not palpable, axillary metastasis was found in 39 per cent. In most cases these enlarged nodes were under the pectoral muscles along the axillary vein. In view of the frequency with which these palpable nodes are found to be inflammatory on microscopic examination I do not believe it is justifiable to refuse operation. In a review of cases of malignant tumor of the breast encountered from 1910 to 1930 I have tabulated the percentage of cases in which there was nodal involvement at the time of operation. It was found that the average percentage of patients who had nodal involvement in this entire period was 64.2 and that the percentage was little different among cases encountered in the last 10 years. In 1930 the percentage was 62.4. This again indicates that cases are being seen too late in the course of the disease to expect the best results from surgical treatment.

From a surgical standpoint, the cases of lesion of the breast which require most careful consideration are those in which a definite diagnosis cannot be made clinically and in which the question arises of whether it is best to keep the patient under observation or to treat the condition surgically. In all cases in which there is a single localized tumor without definite clinical signs of malignant disease, the only safe way to establish a definite diagnosis is by surgical removal of the tumor for microscopic examination. The tumor should be removed by wide excision, well away

from the limits of the growth and without trauma to the lesion. Usually I prefer to remove a wedge-shaped piece of tissue including the tumor. Microscopic examination of the tumor should be made immediately after its removal before the wound is closed. If the tumor proves to be malignant the operation should be completed as a radical amputation.

I do not believe that it is ever justifiable to remove any growth from the breast without immediate microscopic examination of frozen sections of the tissue and the manner of completing the operation is indicated by examination of the tissue. The poorest surgical results in carcinoma of the breast are obtained from secondary radical amputation after primary partial removal of the tumor. In a review of the series mentioned I found that 11 per cent of the patients had undergone a primary minor operative procedure and in these cases I performed secondary radical amputation. In this group lymphatic involvement had occurred in 79 per cent of cases as compared with 64 per cent of cases in which primary radical operation had been performed. The results of radical secondary amputation are correspondingly less satisfactory than after primary radical amputation. These cases in which a primary minor operation had been done do not give a correct impression of the results because in approximately 50 per cent of them operation could not be done, the condition was hopelessly inoperable at the time the patients presented themselves at the clinic. This is particularly true when some type of escharotic paste had been used on the breast primarily for in more than 80 per cent of these the condition is inoperable.

The best surgical results are obtained by primary radical amputation. In this series of 257 cases in which operation was performed between 1910 and 1936 the cases were divided into groups depending on whether there was nodal involvement. In the series without nodal involvement, 71.2 per cent of the patients are living 5 years after operation, 52.9 per cent are living 10 years, and 40.7 per cent 15 years after operation. In the cases in which there is involvement of nodes the results are not as satisfactory but probably are more favorable than when there is metastatic malignancy from growths elsewhere in the body. In the group of patients with nodal involvement, 26.3 per cent are living 5 years after operation, 14.6 per cent 10 years after operation and 10.5 per cent 15 years.

The technique of the radical operative procedure has been fairly well standardized. I do not make a uniform type of incision in the skin, for I

believe that the best results are obtained when the incision is planned in each case so as to remove the greatest amount of skin over the diseased portion and leave the least deformity and restriction of motion of the arm. If the incision is properly planned in accordance with the situation of the tumor sufficient skin can be removed so that there is little danger of local recurrence and skin grafting is rarely necessary except in the most extensive cases. In a general way if the tumor is in the upper or lower quadrant of the breast a vertical incision will give the best results in completely removing the growth and in giving adequate exposure for deep dissection. If the growth is in the extreme inner or outer quadrant of the breast a transverse incision is usually best. After the cutaneous incisions have been outlined dissection of the subcutaneous tissue is made around the entire operative field, the median portion of the dissection being carried to the median line of the body, the lateral portion to the border of the latissimus dorsi muscle extending below over the upper portion of the rectus fascia and above to the clavicle. Approximately two-thirds of the clavicular portion of the pectoralis major muscle is then divided and its attachment severed from the humerus. The lymph nodes along the upper portion of the brachial vessels are then thoroughly removed and the dissection is carried to the lower border of the pectoralis minor muscle. The attachment of this muscle to the coracoid process of the scapula is then severed. The dissection of the axillary and sternal lymph nodes is entirely completed, all of the nodes that lie along the lateral thoracic wall and in the axilla being removed, both above and below the axillary vessels, to the point where the axillary becomes the subclavian vein. The branches of the axillary vessels are caught and ligated as the dissection of the lymph nodes proceeds toward the sternum, the long thoracic and subscapular nerves being preserved. This completely outlines the tissues to be removed which are still attached to the thoracic wall, and which consist of the breast, the subcutaneous tissue, the axillary nodes and node-bearing fascia, the pectoralis minor muscle and the greater portion of the pectoralis major muscle. These structures are then dissected from the thoracic wall starting from the lateral aspect, ligating the perforating intercostal vessels. The anterior sheath of the rectus muscle is removed as the dissection proceeds toward the median line and all the carcinoma bearing tissue is removed in one mass.

The results of radical operation depend to a great extent, on the thoroughness with which the

TABLE I—RADICAL AMPUTATION FOR
CARCINOMA OF THE BREAST

(5 and 10 Year Results According to the Grade of Malignancy in 1,911 Cases in Which Operation Was Performed from 1910 to 1917 Inclusive)

Grade of malignancy	Cases	Per cent of total cases	Patients living, per cent of cases in grade	
			1 Year	years
Involvement of lymph nodes				
		7	00	80
		7 6	0	15
3	130	14.5	10.9	3
	871	19.9	9	3
Total	1001	24.5	5	27
No involvement of lymph nodes				
		9	93	83.5
	66	5.5	76.4	45.7
	15	21	61.8	46.9
		10.5	35	25.6
Total	176	18.7	66.4	44

operative procedure is performed. I do not think the importance of this can be overestimated inasmuch as the only possibility of obtaining cure from surgical treatment is from the original operative procedure. It has been my experience that secondary operative procedures have been of little benefit.

In cases in which a definite clinical diagnosis of malignant disease can be made the condition usually is fairly well advanced and the decision as to the type of treatment to be instituted depends on the amount of involvement present. In cases in which the lesion is unilateral, and clinical examination does not reveal evidence of distant metastasis primary radical amputation should be performed. In certain cases in which the supraclavicular nodes are palpable, radical amputation may be performed because of the possibility that the nodes are inflammatory. In such cases it is best to apply radium to the nodes subsequent to operation because of the possibility that they may harbor metastatic growths. I do not believe that operation is advisable if clinical examination demonstrates definite distant metastasis to the lungs, bones or liver. If there is an extensive ulcerating lesion and a possibility of removing the ulcerated portion and closing the skin, I believe radical amputation should be performed rather than a more palliative procedure such as a simple amputation. There is very little addi-

tional risk in radical amputation as compared with simple amputation and in cases of the kind mentioned, radical operation is in reality palliative. I believe that the prognosis is much better when radical operation is performed.

The most valuable indications as to prognosis in cases of carcinoma of the breast are obtained by study of the grade of malignancy present and by determining the extent of the disease as indicated by the absence or presence of lymphatic involvement. We are now making a study of the grades of malignancy in all cases of carcinoma of the breast in which operation has been performed since 1910. This study has not been completed, but the results are known in 1,911 of the cases in which operation was performed from 1910 to 1917 inclusive and this I believe is a sufficient number to permit a preliminary report. The results of this study are uniform throughout in that the results of operation in the presence of lower grades of malignancy were much better than in the presence of higher grades, and the results in cases in which nodal involvement was absent were uniformly better in all grades than in cases in which nodal involvement was present. The results of this study are shown in Table I.

The results in those cases in which postoperative roentgen treatment had been given and those in which it had not been given were compared. In the cases in which there was lymphatic involvement and roentgen treatment had been given the average proportion of patients with lesions graded 3 or 4 who were living after 3 and 5 years, was 4.8 per cent more than among a similar group who had not had roentgen treatment, and the average proportion of patients with lesions graded 1 or 2 or 3 or 4, who were living after 10 years, was 4.2 per cent less than among a similar group who had not had roentgen treatment. The proportion of patients living after 3 or 5 years, whose lesions were graded 1 or 2 was 2 per cent less than in a similar group who had had roentgen treatment. These results indicate that postoperative roentgen treatment may be of benefit for highly malignant lesions, particularly if there is lymphatic involvement, but it should not be used as a routine measure since the results are less satisfactory when it is used for lesions of lower grades of malignancy, and if the results after 10 years are considered, they appear to be less satisfactory when lesions are of the higher grades of malignancy. I believe that roentgen treatment is of benefit in selected cases but in certain other cases it may be detrimental. If severe reaction follows, its use should be discontinued. I have seen a number of cases of this

type in which distant metastasis occurred earlier than would have been expected from the degree and extent of the malignancy found at the time of operation. Because of lack of uniformity of results in treating the different grades of malignancy and because there was no marked variation in the results obtained whether or not roentgen rays were used I believe the practical importance of this study is that patients who are accepted for surgical treatment should have as radical and thorough an operative procedure as possible, since roentgen rays cannot be depended on to remove any malignant tissue that may be left as a result of incomplete operation.

CONCLUSIONS

1 Present clinical methods are inadequate to detect malignancy until it is fairly well advanced.

2 Microscopic examination should be made in all doubtful cases and this should be followed immediately by radical operation if the lesion proves to be malignant.

3 The best surgical results are obtained from primary radical amputation in cases in which there is no involvement of lymph nodes. In cases of this type reviewed 71.2 per cent of patients

were living 5 years after operation, 52.9 per cent were living 10 years after operation and 40.7 per cent were living 15 years after operation. In the cases in which there is involvement of lymph nodes the results are not as satisfactory but probably more favorable than those obtained when there are metastatic growths elsewhere in the body. In cases of this type reviewed 26.3 per cent of patients were living 5 years after operation, 14.6 per cent were living 10 years after operation and 10.5 per cent were living 15 years after operation.

4 The surgical results are not as satisfactory in cases in which secondary radical amputation is done following a previous primary partial operative procedure.

5 The most important indications as to prognosis were the degree of malignancy and the presence or absence of involvement of nodes.

6 Surgical results are more satisfactory in the presence of lower grades of malignancy.

7 Postoperative roentgen therapy is not a definite auxiliary to surgical treatment. In selected cases in which the grade of malignancy is high it may be of value but it is of no benefit if the grade of malignancy is low.

PROGNOSIS IN GASTRIC CARCINOMA TREATED BY RESECTION

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ANALYZING the histories of all of the cases of carcinoma of the stomach entering the Presbyterian Hospital between January 1 1920 and December 31 1929 (1) I found that, where sufficient data were obtainable, the patients waited an average of 5.3 months before seeing a doctor and that a further delay of 8.3 months occurred before these patients came to

operation! The reasons for the delays are numerous, the most common being the fact that the patient had had some previous stomach trouble. However, lack of careful examination of the patient was very often a cause and the responsibility rested squarely with the physician. A third, which was present all too frequently was the fact that many physicians still feel that the patient

	I	II	III	IV	V	VI	VII
Hospital number	86445	86163	125814	87090	143163	99654	153423
Sex and age	F 8	M 64	M 5	M 3	M 45	M 65	M 62
Date of operation	3-30-13	9-13-13	9-8-20	-9-20	3-2-4	9-13-4	9-2-13
Duration of symptoms	3 yr.	mos.	3 yr.	3 mos.	8 yrs.	8 mos.	3 mos.
Chief symptoms in order of occurrence							
Pain	5	—	3	1	—	4	—
Weakness	—	—	—	—	—	—	—
Indigestion	—	—	—	—	—	—	—
Fullness	3	—	—	—	—	—	—
Loss of appetite	—	3	—	1	—	—	3
Loss of weight	3 mo.	—	3 to 6 mo.	—	13 to 24 mo.	20 mo.	—
Vomiting	—	—	—	3	—	—	—
Knowledge of tumor	—	—	—	—	—	—	—
Hemorrhage	—	—	—	—	3	3	—
Anorexia	—	—	—	—	—	—	—
Emaciation	—	—	—	—	—	—	—
Ulcus history	No	—	13 yrs.	—	8 yrs.	—	No
Physical examination							
Emaciation	—	—	Yes	Yes	No	Yes	Yes
Glands	No	No	No	No	No	Enlarged	No
Tumor	Yes	Indurated	No	No	No	Yes	Yes
Tenderness	No	Yes	No	No	Yes	Yes	—
Laboratory							
Hemoglobin	70	84	81	80	70	45	45
Eosinophil	N	Yes	Yes	No	Yes	Yes	Yes
Acidity	—	—	18	30	25	—	18
Free	—	—	40	60	40	17	—
Total	—	—	—	—	—	—	—
Lactic	—	—	—	—	—	—	—
X-Ray							
Obstruction	No	—	—	—	Yes	—	No
Stasis	Pylorus and parts media	—	End of antrum	End of antrum	Antrum and pylorus	Pylorus	Antrum. Last cure
Operative findings							
Pylorus	—	Mass	Mass	Mass	—	—	—
Lower curvature	—	—	—	—	Mass & ulcer	—	—
Pars media	—	—	—	—	—	Mass	—
Greater curvature	Mass	—	—	—	—	—	Mass
Pylorus	—	Yes	—	—	Yes	—	—
Glands	—	—	—	—	—	—	—
Fluid	—	—	—	—	—	—	—
Pathology							
Microscopic	Adenocarcinoma	Adenocarcinoma	Adenocarcinoma	Papillary cystic carcinoma	Sclerosing adenocarcinoma	Adenocarcinoma	Ulcus carcinoma
Postoperative history	Living 7 yrs. Recurrence	Dead 18 mo. yrs. Recurrence	Living yrs. Well	Dead 9 yrs. Recurrence	Dead 3 yrs. Recurrence	Living 13 yrs. Well	Living 6 yrs. Well

is hopelessly doomed from the start and that operative interference carries a high mortality with little or no relief.

On account of such notions in the minds of many physicians and patients, it has been deemed worth while to report those cases of proved carcinoma which have survived longer than 5 years. During the 10-year period 417 cases were discharged with the diagnosis of carcinoma of the stomach. Almost exactly one half or 208, of these were either inoperable at the time they were seen or refused operation. While it must be admitted that some of these patients had very few symptoms before they were considered inoperable,

the majority of them were the victims of procrastination. According to most postmortem statistics (2), three-fifths of gastric cancers occur at or near the pylorus and should give symptoms relatively early. Only about one fifth are in the cardiac portion and beyond the range of operability from the outset. Of the 209 cases which were operated upon, 30 per cent were found to be so extensive that the operation was purely exploratory. Fifty eight resections were done. The operative mortality has been materially reduced in the last few years by more careful preparation of the patients and while it still seems high (about 18 per cent) it is only a trifle higher than for gastro-enteros-

VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
166706	170843	172072	176107	173146	185201	182408	210131	213412	217787
M 57	M 50	M 58	F 56	M 52	M 49	F 73	M 60	M 41	F 30
5 10-23	0-25-23	1-10-24	2-20-24	4-30-24	1-21-25	5-6-25	3-20-27	5-0-27	11 3-27
18 mos.	3 mos.	3 mos.	2 yrs.	3 mos.	13 mos.	2 yrs.	2 yrs.	4 yrs.	10 mos.
1	—	—	—	1	1	—	1	1	1
3	—	1	—	3	4	3	3	—	—
—	—	—	1	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—
4	35	—	4	30	43	20	17	34	30
—	—	—	—	—	6	—	4	—	—
—	—	—	—	—	5	—	—	—	1
—	—	—	—	—	—	—	3	8	—
—	1	—	—	—	2	4	—	—	—
No	No	6 mo.	No	No	15 yrs.	No	Yes	Yes	—
Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes
Inoperable	No	N	No	—	No	No	No	No	No
Yes	Yes	Yes	Yes	Yes	Bleeding	Yes	No	No	Yes
Yes	—	No	No	Yes	Yes	No	No	No	—
Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes
21	80	37	29	45	28	65	90	—	23
Yes	—	Yes	Yes	Yes	—	—	Yes	Yes	—
43	0	—	—	0	18	—	25	Much	0
61	24	30	—	11	36	—	20	free acid	15
—	—	—	—	0	—	—	—	—	—
—	—	—	—	Yes	Yes	N	Yes	No	—
Central	—	—	—	Pylorus	Pylorus	Central	Pylorus	Pylorus	Lower half
third	—	—	—	—	—	—	—	—	—
—	Mass	Mass	Mass	Mass	Mass	—	Mass & ulcer	Mass & ulcer	Involved
—	—	—	—	—	—	—	—	—	Mass
—	—	—	—	—	—	—	—	—	—
Mass	—	—	—	—	—	Mass	—	—	—
Yes	—	No	—	—	Yes	—	Yes	—	N
—	—	—	—	Yes	—	—	—	—	—
Diffuse	Edyphic	Adenocar	Adenocar	Papillary	Adenocar	Papillary	Adenocar	Ulcer	Colloid
scirrhous	carcinoma	cinoma	cinoma	carcinoma	cinoma	carcinoma	cinoma	carcinoma	carcinoma
carcinoma	(carcinoma	—	—	—	—	—	—	—	—
—	staple)	—	—	—	—	—	—	—	—
Dead	Dead	Dead	Living	Living	Dead	Living	Living	Living	Living
5 yrs.	5 1/2 yrs.	3 yrs.	8 yrs.	8 yrs.	5 yrs.	1 1/2 yrs.	4 yrs.	4 yrs.	4 yrs.
Recurrence	Recurrence	Recurrence	Well	Well	Postoperative	Well	Well	Well	Well
—	—	—	—	—	pneumonia	—	—	—	—
—	—	—	—	—	antopy	—	—	—	—
—	—	—	—	—	no carcinoma	—	—	—	—

tomy in cancer cases. The operation of choice has been wide resection of the mass together with all adjacent glands followed by Billroth II closure, or some modification of it such as the Polya or Balfour.

Of those patients who survived operation, 46.1 per cent lived over 3 years and 39.5 per cent have survived over 5 years, 1 patient being alive and well at the end of 12 years. In addition to this group 2 other patients have been observed during this period who were operated upon in 1915 surviving 16 and 17 years. Although a 5 year survival is by no means a criterion of a cure and recurrence may occur even after 15 years, the amount of relief and comfort to these patients has been enormous, especially when compared to the hopeless picture of medical management or the palliative operation of gastro-enterostomy. Following are brief abstracts of the histories of the patients operated upon prior to 1928 who have survived at least 5 years.

CONCLUSIONS

The terrific mortality from carcinoma of the stomach can be lowered by more careful work on the part of medical men and by judicious propaganda.

Seventeen cases of gastric carcinoma surviving the five-year period are recorded.

Wide resection carries very little more mortality than palliative operations and in this series, 40 per cent of the patients who recovered from operation have survived more than 5 years (100 per cent follow up).

Barring the discovery of some real cancer cure, our efforts must be directed to earlier diagnosis and prompt radical resection which will improve very greatly the outlook in this all too common carcinoma.

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MALIGNANT TUMORS OF THE KIDNEY AND PELVIS OF THE KIDNEY

FIVE YEAR CURES FOLLOWING NEPHRECTOMY WITH PARTIAL OR COMPLETE URETERECTOMY

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FOLLOWING surgical removal of malignant tumors of the kidney at The Mayo Clinic from 1901 to January, 1927 110 patients have lived for 5 or more years. Inasmuch as malignant renal tumors were removed from 256 patients during this period there have been cures for 5 years or more in approximately 43 per cent (42.99) of these cases. Of further interest is the fact that 68 of the 110 patients have lived from 5 to 10 years 22 have lived 10 years or more, 15 have lived from 15 to 20 years and 5 have lived more than 20 years (Table I). Although the purpose of this paper is primarily to report the number of patients surviving longer than 5 years after the removal of malignant tumors the fact must not be lost sight of that among those patients who lived less than 5 years the surgical treatment directed toward the eradication of the disease undoubtedly prolonged the patients' lives and made life more comfortable.

In 41 additional cases the malignant tumor of the kidney was so extensive as determined by incision and exploration of the tumor that the lesion could not be removed and after specimens were taken from the tumor for microscopic examination, roentgen rays and radium treatment was instituted. Seven (17 per cent) of these 41 patients who had inoperable malignant renal tumors lived for more than 5 years (Table II). This group of 41 inoperable cases might well serve as a control group in evaluating the benefits of surgical removal of malignant renal tumors, and emphasis might be placed on the fact that in the group of operable cases in which the tumors were removed the percentage of 5 year cures was 43 whereas among those cases in which the lesion could not be removed surgically because of its extent, even though the tumor was treated extensively by roentgen rays and radium only 17 per cent of the patients lived more than 5 years subsequent to the beginning of such treatment. I should like, however, to give full credit to the apparent benefits of postoperative use of roentgen rays and radium applied over the former site of the malignant lesion as an adjunct to surgical treatment of these lesions. For many years, it has been a routine to give courses of roentgen

rays and radium immediately following recovery of patients from removal of malignant renal tumors, and in the group of 110 cases of 5 year cures, postoperative application of either roentgen rays or radium has been carried out in 33 cases. Roentgen therapy has been of further value in some cases in which highly malignant tumors appeared to have undergone fixation and therefore to be inoperable, in some cases that is after a course of roentgen therapy, the tumor decreased in size and became more mobile, enabling nephrectomy with removal of the tumor, to be accomplished successfully.

PATIENTS LIVING

It would seem that following removal of malignant tumors, if recurrence does not take place within 5 years one can justly anticipate complete and permanent cure. However, in order to determine accurately whether such a conclusion might be accepted as fundamental I have followed the progress of the 110 patients mentioned, and have found that 76 of them are living and well, whereas 34 have died. Analysis of the 34 cases in which the patients have died would indicate that recurrence had taken place in 16 metastasis to various tissues as follows: to the bone in 4, to the lungs in 3 and to the brain in 3. Of the 41 cases which I have designated as inoperable in which treatment was by roentgen rays and radium, although 3 patients lived for 5 years, 2 for 18 years and 1 for 15 years only 1 of the entire series is living at the present time. This would further emphasize the value of surgical removal of malignant renal tumors and the importance of recognition of such a lesion in its removable stage.

LONGEVITY DEPENDING ON BRODERS INDEX OF MALIGNANCY

For the last 10 years the grading of malignant tumors has been routine at the clinic, and Broders index of malignancy has been used. In addition to the grading of the tumors removed during this period at the clinic, Broders and Hand have re-examined grossly and microscopically 193 malignant renal tumors removed between 1901 and 1923, and have graded them on the basis of degrees of cellular differentiation interpreting

TABLE I.—FIVE YEAR CURES IN 256 CASES OF MALIGNANT RENAL TUMORS NEPHRECTOMY WITH AND WITHOUT PARTIAL OR COMPLETE URETERECTOMY

	Cases	Per cent
Lived 5 or more years	110	43
Had roentgen-ray and radium also	33	
Lived from 5 to 10 years	68	
Lived from 10 to 15 years	37	
Lived 20 years	3	
Living at present	70	
Of these patients dead (16 from metastasis)	34	

their results in relation to prognosis. Quoting from their paper The grade of malignancy was found to be higher if patients were less than 40 years of age as the degree of malignancy increased the length of postoperative life decreased. An interesting relation exists between the grade of malignancy of the number of patients dead. Of the patients who have died many more are found among those who had higher grades of malignancy. A larger proportion of those patients living following nephrectomy for malignant renal tumors had carcinomas of lower rather than of higher grade of malignancy. Study of postoperative results in cases of carcinoma of the kidney based on the degree of cellular differentiation in the tumor represents a distinct advance in knowledge of this disease.

In a study of the grade of malignancy of the 110 malignant renal tumors removed from patients who lived 5 years or longer it is noted that grades 2 and 3 occurred most frequently and that in 43 cases the grade was 2 and in 21 cases it was 3. Next in order of frequency were tumors of grade 1, 13 cases. In only 4 cases were there 5 year cures among those in which tumors were of grade 4.

Of further interest are the facts that in the group of 110 cases in which there were 5 year cures, 70 per cent of the patients who had tumors of malignancy graded 1 are living at the present time, 67 per cent of those with tumors graded 2, 63 per cent of those with tumors graded 3 and none of those with tumors graded 4. This, further indicates the accuracy of the method of determining the degree of malignancy and the prognosis in cases of operable malignant renal tumor.

TYPES OF MALIGNANT RENAL TUMOR

Adenocarcinoma or hypernephroma constitute practically all the malignant tumors of the kidney with the exception of primary, squamous cell epithelioma of the pelvis of the kidney. The ratio of squamous cell epithelioma to adeno-

TABLE II.—INOPERABLE MALIGNANT RENAL TUMORS (41 CASES) EXPLORATION RADIUM OR ROENTGEN RAY TREATMENT

	Cases	Per cent
Lived 5 or more years	7	17
Lived 5 to 10 years	6	
Lived 15 years	1	
Living at present time	1	
Dead	6	
From metastasis	4	
From unknown cause	2	

carcinoma is variously estimated to be 1:11 and 1:14. In the series of 110 cases in which 5 year cures were obtained hypernephroma or carcinoma existed in 100 of the cases whereas epithelioma of the renal pelvis were present in 7 and sarcoma in 3.

Sarcoma of the kidney is relatively rare. In an unselected group of 225 cases of malignant tumors of the kidney in which operation was performed in the clinic, only 10 of the tumors were sarcoma, and in the series of 110 in which 5 year cures were obtained, cases of sarcoma numbered 3. The assumption that sarcoma of the kidney affects chiefly young adults has not been borne out in our experience. For example, 8 of the 10 patients with sarcoma of the kidney were adults, whereas the tumors in a series of 13 children with malignant tumors of the kidney were reported by the pathologist as adenocarcinoma, sarcoma and Wilms tumor.

SYMPTOMS OF RENAL MALIGNANT TUMORS

The symptoms of lumbar pain, presence of a tumor in the region of the kidney and hematuria occurred individually or collectively in practically all cases of malignant tumors of the kidney. In a group of 367 tumors of the renal cortex reported from the clinic by Judd and Hand, one of these three symptoms was present in 99 per cent of the cases. Hence early recognition of an abnormal condition of the kidney should not be difficult. That the significance of such symptoms, however occasionally passes unrecognized is evidenced by the fact that in 193 cases of malignant tumor of the kidney in which nephrectomy was performed, the average duration of symptoms before operation varied from 17 to 21½ months. This delay it would seem, should not have occurred.

It is probably unnecessary to emphasize the absolute necessity of cystoscopic examination of patients with hematuria. In the presence of a history of hematuria, the burden of proof that a malignant tumor is not present in the bladder or the kidney lies directly on the examining physician and the only accurate method of determin-

ing or eliminating the possibilities is by use of cystoscopic examination, and of the other refinements of urological diagnosis, such as intravenous urography or pyelography.

The fact that the duration of life and the com-

pleteness of cure are proportionate to the degree of malignancy and the size and extent of the malignant lesion of the kidney should serve as a plea for earlier diagnosis and earlier surgical treatment of this lesion.

CARCINOMA OF THE PROSTATE

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IN 1904 after a study of postmortem specimens I devised a radical operation for carcinoma of the prostate and on April 7, 1904, carried it out on the first patient. The technique of this operation was as follows. The prostate was exposed by the perineum, as in Young's conservative perineal prostatectomy, the tractor having been introduced through an incision in the membranous urethra. After exposure of the posterior surface of the prostate, the diagnosis was confirmed. The operator then proceeded to remove the entire prostate with its capsule and urethra, neck of bladder, lower half of trigone, seminal vesicles and ampullae of the vasa deferentia, thus excising in one block the entire carcinomatous area with a large margin of normal tissue. Closure was then effected by anastomosing the bladder to the membranous urethra.

This operation has now been carried out in my clinic in 40 cases. The total mortality has been about 6 per cent and there is one series of 18 cases with only one death. Had the operation been confined to cases in which the prognosis was good, both the mortality rate and the percentage of recurrences would have been greatly reduced.

At the request of Dr. Martin I have confined this report to those cases in which the operation was performed five years ago or longer. I find in this category 29 cases. We have made a careful study as to recurrences in 25 patients who left the hospital and beg leave to report as follows. Seven patients are living and well without recurrence or metastases. The duration since

operation has been 5 years in 3 cases, 7 years in 2 cases, 9 years in 1 case and 18 years in 1 case. Five patients have died without recurrence or metastases. These lived the following periods: 1 patient, 6 years; 2 patients, 7 years; 1 patient, 9 years; 1 patient, 13 years. There are therefore, 12 patients who passed the 5 year period or 48 per cent cured.

The early patients all had incontinence of urine when on their feet. I believe that this was due to interference with the blood and nerve supply of the external sphincter. I therefore changed the operation. By dissecting beneath the anterior pelvic fascia I found it possible to preserve these and since then a large percentage of the patients have had complete urinary control.

On account of the marked encapsulation of the prostate by its own capsule and two layers of pelvic fascia, which surround it, carcinoma of the prostate is confined within three fascial coverings and rarely penetrates them until late. As the disease progresses it generally travels upward into the region behind the bladder and in front of the two layers of fascia. Carcinoma of the prostate therefore, probably presents the best prognosis for a radical cure of any of the deep seated organs, this remarkable encapsulation, confining the disease to the limits of the prostate itself, being the finest safeguard against invasion of adjacent tissue and giving the surgeon a splendid opportunity for a radical cure with the operation here presented which shows 48 per cent of cures over 5 years.

MALIGNANT TUMORS OF THE BLADDER

A REVIEW OF 165 CASES IN WHICH THE PATIENTS LIVED FIVE YEARS OR MORE FOLLOWING VARIOUS SURGICAL PROCEDURES

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THE results following various surgical procedures in the treatment of carcinoma of the urinary bladder although not excellent are nevertheless gratifying particularly when it is considered that the average patient with carcinoma of the bladder may not seek treatment until several weeks after the onset of the disease. The high degree of perfection attained by the urologist in diagnosing the type of lesion, its extent, situation and degree of malignancy is a distinct aid in determining the type and magnitude of the operation as well as in evaluating the end-results.

At The Mayo Clinic from 1910 to January 1927 600 malignant tumors of the bladder were treated by various surgical procedures, consisting of resection, excision, surgical diathermy combined with ligation and reimplantation of the ureter, transplantation of the ureters to the back with total cystectomy and treatment by radium. In this group of 600 patients, 165 (about 28 per cent) were cured for 5 years or more. One hundred three of the 165 patients have lived from 5 to 10 years, 43 have lived 10 years or more, 14 have lived from 15 to 20 years, and 5 have lived more than 20 years. Sixty seven (40.6 per cent) of the 165 patients had recurrences although 42 of the 67 are now living and free from symptoms referable to the bladder. The deaths of 19 of the 25 patients were the result of local recurrence or metastasis. One hundred sixteen (70 per cent) of the 165 patients are alive and free from symptoms.

The choice of operation for malignant lesions of the bladder is determined principally on their site, extent, and grade of malignancy. It is known that those situated at the base of the bladder are of a higher grade of malignancy and are of the infiltrating type, usually involving one or both ureters. Those situated in the lateral walls and dome are more amenable to surgical attack and are less malignant. The lesions in 110 (66.66 per cent) of our 165 cases were on the lateral walls and dome, whereas 55 (33.33 per cent) involved the base, trigone, urethra, and ureteral orifices.

Seventy-four of the patients were treated by resection or excision, and of this number 28 (approximately 38 per cent) had recurrences. Fifty patients lived from 5 to 10 years, 17 lived 10

years or more and 7 lived from 15 to 20 years. Resection and excision combined with other surgical procedures were used in treating 70 of the 165 patients, and of this number 33 (47.1 per cent) had recurrence. However 35 patients lived 5 to 10 years, 25 lived 10 years or more, 6 lived 15 to 20 years, and 4 lived more than 20 years.

Transvesical electrocoagulation (diathermy) was used in treating certain tumors of the bladder mostly of the infiltrating type confined to the base of the bladder and considered non-resectable. Seventeen of the 165 patients were treated by this method. There were 5 recurrences (29.2 per cent). Sixteen of the 17 patients lived from 5 to 10 years and 1 patient lived more than 10 years. Fifteen (88 per cent) of the 17 patients treated by electrocoagulation are living and are free from symptoms referable to the bladder. If it is considered that the cases were judged to be inoperable, the results indicate that the patients who lived less than 5 years, and who were treated by diathermy undoubtedly lived longer and in greater comfort because of this treatment. It should, therefore, be considered a very effective method of treating not only the more malignant inoperable lesions, but those more favorably situated and less malignant.

Not infrequently palliative cystostomy for extensive malignant lesions of the bladder with the subsequent application of radium is justified. Two patients with such lesions were so treated with surprisingly favorable results. One patient lived 5 years and the other is living more than 15 years.

Total cystectomy with transplantation of the ureters to the back was performed on 2 patients. There has been no recurrence and both patients are living, 1 more than 5 years and the other more than 10 years.

The grade of malignancy was studied in 151 of the 165 cases in which the patients are living 5 years or more. In 14 the malignancy was not graded. In 38 cases the malignancy was graded 1, in 67 it was graded 2, in 30 it was graded 3, and in 16 it was graded 4. It should be noted that 105 (63.63 per cent) of all the malignant tumors were of the less malignant type (grades 1 and 2). Only

9.69 per cent were graded 4. It is further of interest that in the group of 165 patients living 5 years or more 76 per cent who had malignant tumors graded 1, 67 per cent of those with tumors graded 2, 66 per cent of those with tumors graded 3 and 62 per cent of those with tumors graded 4 are living at the present time. The relative high percentage of 5 year cures of patients with tumors graded 3 and 4 is striking but serves to emphasize the importance of treating malignant lesions of the bladder which at first seem inoperable.

A study of the recurrence of tumors according to the grade of malignancy reveals a rather uniform percentage of recurrence of tumors of all grades. In 67 cases the patients survived 5 years or more but they had definite local recurrences. Of these 67 patients, 15 had recurrent growths graded 1, 12 of whom are living; 33 had recurrent growths, graded 2, 20 of whom are living; 11 had recurrent growths graded 3, 5 of whom are living; and 4 had recurrent growths graded 4, 3 of whom are living. Considering the entire recurring group, 42 patients (62 per cent) have lived from 5 to 10 years, 21 (31 per cent) have lived 10 years or more, 2 (3 per cent) have lived 15 to 20 years and 2 (3 per cent) have lived more than 20 years.

Postoperative recurrence or extension of the malignant growth takes place regardless of the method of removal usually in the form of implants, either before or after operation or by direct extension beyond the tissue removed or along the lymphatic structures. Since recurrent growths of all grades were noted rather uniformly, it would seem that recurrence would develop in a variable percentage of cases regardless of the degree of malignancy. Recurrence after radical excision or electrocoagulation of a growth of low malignancy

is not so likely to occur as it is following the same procedure for a growth graded 3 or 4.

For many years it has been a routine procedure at The Mayo Clinic (introduced by Crenshaw) to request such patients to return in 3 months for a check up on the condition of the bladder then again in 3 months, then in 6 months and then in 1 year. In this manner many recurrent growths are discovered before symptoms develop thereby making it possible greatly to improve the end results. Unfortunately some patients disregard the follow up note and fail to return until there is extensive local recurrence requiring secondary surgical procedures.

Of the 67 patients who had recurring lesions in the bladder, 36 (53.73 per cent) were treated by transurethral fulguration or by radium. Twenty-six patients (75 per cent) so treated are living and are free from symptoms. Twenty patients (29.85 per cent) of the 67 required secondary surgical procedures by the suprapubic route. Only 8 (4 per cent) are now alive. The condition of 5 patients who did not return for a check up was considered inoperable according to the symptoms as given in correspondence. Only 2 patients (4 per cent) are known to be living. From the correspondence of 6 patients of the group recurrence was considered doubtful all of this group are now alive and well for periods of 5 to 15 years after operation.

It is apparent, therefore, that if results of treatment of malignant tumors of the bladder are to be further improved, then there must be a rigid selection of the surgical procedure that should be applied, as determined by the situation, extent and grade of malignancy of the lesion, together with a rigid follow up system.

TUMORS OF THE TESTIS

FIVE YEAR CURES FOLLOWING RADICAL OPERATION

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THE following presentation is an attempt to ascertain the value, if any of radical surgery in tumors of the testis and, in order to compare results, certain important characteristics of these tumors with reference to surgical treatment should be recognized and these characteristics may be discussed under the three headings (1) pathological, (2) clinical, and (3) therapeutic.

Pathological characteristics The exact pathological nature of testicular tumors remains uncertain. New-growth may arise from any type of cell present in the testis so that connective tissue epithelial and mixed type tumors are possible. What ever interpretation is made as to character and origin, it should be well understood that both pathologists and clinicians agree that for practical purposes all tumors are to be regarded as malignant. In the pathological differentiation of these different tumors there are two outstanding characteristics. In one group is a mixed tumor type of *teratoma* in which all three germ layers (epiblast, hypoblast, and mesoblast) may be more or less equally represented in a typical tridermal *teratoma*, or there may be a one-sided overgrowth, first, of the epiblast, forming squamous epithelioma, basal celled carcinoma, chorio-epithelioma or a neuro-epithelioid type tumor second of the hypoblast, forming the simpler papillary adenofibromata adenocarcinoma or cirrhotic carcinoma and, third of the mesoblast, forming cartilaginous, myomatous or mesenchondro-endotheliomatous tumors. According to Bell, hypoblastic overgrowth is the commonest and epiblastic least common. In the other group are the homogeneous monocellular type of tumors which, according to one view (Chevassu and Bell) arise from the adult cells of seminiferous tubules just as cancer develops from an uncontrolled proliferation of adult cells from other glandular structures but, according to Ewing, are a one-sided cancerous overgrowth in a tumor primarily tridermal. Whatever view is adopted, the clinical distinction of a mixed tumor or *teratoma* from a homogeneous monocellular tumor or *seminoma* is of considerable importance. It seems fairly well established that the *seminoma* is radiosensitive but that the *teratoma* is radioresistant. Both are highly malignant and metastasize by preference through primary lymphatics. Sarcoma is now known to be a

very rare tumor of the testis, although in the past it was frequently reported and probably referred to the pure round-celled *seminoma*. The only pure sarcomata of the testis are those arising from a connective tissue framework of which lympho-sarcomata are commonest. Fibrosarcoma may arise from testicular tunics. Other sarcoma-like areas of heterogeneous tumors are in all probability a mesoblastic overgrowth of the testicular tumor or a type of sarcomatous change to which Bell applies the term "carcino-sarcoma" occurring in a structure essentially carcinomatous. For practical purposes, therefore, the clinician can recognize a mixed tumor or *teratoma*, in which the rare chorio-epithelioma belongs, and the pure unicellular *seminoma* with which the questionable sarcoma can be satisfactorily grouped.

A marked pathological characteristic of both these two types of tumors is mode of metastasis. *Teratoma* tends to metastasize earlier by way of primary lymphatics than *seminoma* but either type may show early general metastases, particularly to the lungs and liver. The primary lymphatic chain of the testicle has been well established anatomically and is the so-called pre-aortic lymph zone (Fig. 1).

Clinical characteristics The cases of testicular tumors can be divided into three definite clinical groups, according to the nature of the growth and the absence or presence of evidence of metastases as determined by abdominal palpation of glandular masses or the X-ray indication of lung or other invasion. Group 1 the *seminoma* with or without clinical evidence of metastasis group 2 the *teratoma* with clinical evidence of metastasis and group 3 *teratoma* without clinical evidence of metastasis. This grouping is of importance in the application of surgery.

Therapeutic characteristics There are now three recognized procedures in the treatment of a testicular tumor (1) simple castration, (2) radiation with or without castration, and (3) radical operation in which the testicle and its primary lymph zone are removed. The fact that the *seminoma* type tumors are radiosensitive and the *teratomata* are not gives at once a basis for differentiation of tumors with reference to surgical treatment. Experience has also taught that if metastases are evident on clinical study neither

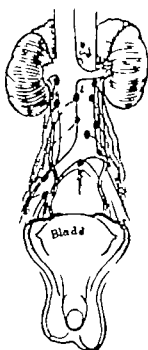


Fig. 1 The primary lymphatic chain of the testicle.

simple castration nor an attempted radical operation can be successful. This means that the clinical group 1 above should be treated by radiation either with or without castration, that group 2 is a hopeless group and can only be treated palliatively which until more is known about the effects of radiation, does not prohibit its trial in all these advanced cases and that group 3 are the only cases in which an attempt to perform a radical operation is ever indicated. It will be found that there will be a certain number of cases in which radical operation is attempted and in which there had been no clinical evidence of metastases but in which inoperable masses will be found. It is at once obvious that simple castration will cure only those cases in which the testicle has been removed before any metastases have occurred, that there will be a certain number of radical operations before metastases have occurred but that in those cases in which metastases have spread into the primary pre-aortic lymph zone their radical removal is the only hope of cure when radioresistant.

The radical operation for teratoma testis The feasibility and ease of an anatomical dissection of the primary pre-aortic lymph zone of the testicle is now fully established. More than 100 cases of radical resection have been performed by American surgeons with only one surgical death from pneumonia 10 days after operation. This is sufficient proof that the operation itself is neither dangerous nor difficult. With these 100 are in-

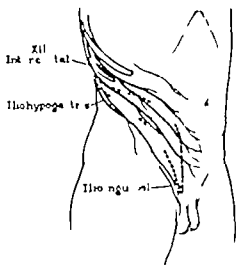


Fig. 2 Line of incision.

cluded 20 cases which were found after retroperitoneal exposure to be inoperable, which means that a large number of other cases must have presented difficulties of gland resection from vena cava and aorta but in all of which no serious damage or surgical injury was done as there has been no case of hemorrhage or accidental death at the time of operation. The technical steps of the operation have been thoroughly described elsewhere¹ and are indicated in Figures 2, 3 and 4. The objection by those who have not done the operation that the whole gland area cannot be removed anyway and so why attempt it is answered by proof of cure by lymphatic resection of cases with lymph gland metastases. The completeness and thoroughness of the gland resection depends as much on courage determination and a conviction that the procedure is right as on skill. The experience of Hepler cited below indicates that the abdominal resection should be extended above the renal pedicle.

In order to evaluate the results obtained by this operation the cases of clinical group 3 teratoma without clinical evidence of metastasis, may be advantageously subdivided into subgroup A, cases which proved to be inoperable or with mistaken diagnosis and which, therefore, can be omitted from the consideration, subgroup B, cases in which the lymphatics removed at operation show no evidence microscopically of metastasis and subgroup C, cases in which microscopic evidence of metastasis is found in the lymphatics successfully removed. From what has been said, it is

Hinman, Frank. The radical operation for teratoma testis with the report of five cases. *Surg., Gynec. & Obst.*, 19 0, xxviii 495-503.
Hinman, Gibson, and Kutzmann. The radical operation for teratoma testis: An analysis of seventy-nine cases, ten of which are personal. *Ibid.*, 1923, xxviii, 499-511.

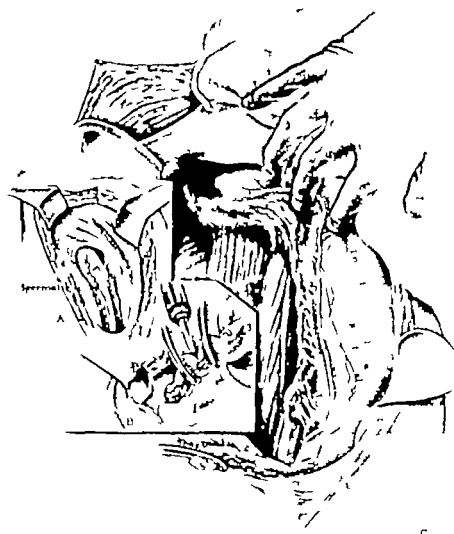


Fig. 3. A Exposure of cord B division of cord with cauterizer C stripping back peritoneum.

obvious that all cases of teratoma in subgroup C could be cured only by radical surgery. It is still an open question whether in a case of pure seminoma with or without clinical evidence of metastases (clinical group 1) radical resection should be attempted or entire trust put in deep X ray therapy.

The cases which are analyzed have been gathered from four sources (1) personal cases of radical operation (2) cases of radical operation by other American surgeons, the majority of which have never been reported and the information regarding which has been obtained by letter (3)

cases of simple orchidectomy with or without radiation gathered from the same source and (4) authentic cases of 5 year cures of abdominal metastases by deep X ray reported to the California Cancer Commission.

Twelve personal cases. There are 9 personal cases which were successful (3 in Group A excluded) all but one of which (Case 4) had teratoma.¹ In 3 cases (Cases 6, 8, and 9) no microscopic evidence of metastases was found in the gland tissues removed. One died within 11 months with

Two radical operations have been done since this paper was written. In one (J. on file) no metastases were found as tumor removed, in the other (Thomas) numerous metastatic glands were removed.



Fig. 4. Completion of operation.

extensive metastases to lung liver and abdominal glands. The other 2 are alive Case 8 for 8 years and 9 months Case 9 for 2 years and 10 months. In 6 cases microscopic evidence of metastases in the gland tissues removed at operation was found Three have died of carcinomatosis Case 1 within 9 months Case 4 18 months and Case 6, 11 months. Of the 3 cases living all were alive and well at last report, Case 2 14 years and 8 months, Case 3 2 months (when last heard from, September 20 1918) and Case 8 4 years and 10 months. This gives a cure in 2 cases in which metastases were removed surgically (namely Cases 2 and 5) and in one case in which no metastases were found or removed surgically

(Case 8) The facts relative to these 9 cases and the patients names are given in Table I

Ninety-one cases of radical operation by other American surgeons The information of this series of 91 cases was obtained by letter sent to all members of the American Urological Association and to a few general surgeons who it was known had done the operation or of whom this was learned from the answers of some of the urologists. These cases are analyzed in four subgroups (1) Twenty cases in which the operation was attempted but found impossible of completion subgroup A inoperable cases Table II. (2) Thirty three cases in which no microscopic evidence of metastasis was found in the lymphatic



Fig. 3. *B* Exposure of conl. *B* division of conl with cautery. *C* stripping back peritoneum.

obvious that all cases of teratoma in subgroup C could be cured only by radical surgery. It is still an open question whether in a case of pure seminoma with or without clinical evidence of metastases (clinical group 1) radical resection should be attempted or entire trust put in deep X-ray therapy.

The cases which are analyzed have been gathered from four sources: (1) personal cases of radical operation; (2) cases of radical operation by other American surgeons, the majority of which have never been reported and the information regarding which has been obtained by letter; (3)

cases of simple orchidectomy with or without radiation gathered from the same source; and (4) authentic cases of 5 year cures of abdominal metastases by deep X-ray reported to the California Cancer Commission.

Twelve personal cases. There are 9 personal cases which were successful (3 in Group A excluded) all but one of which (Case 4) had teratoma.¹ In 3 cases (Cases 6, 8, and 9) no microscopic evidence of metastases was found in the gland tissues removed. One died within 11 months with

Two radical operations have been done since this paper was written. In one (Van Hest) no metastases were found on tissues removed, in the other (Thomas) numerous metastatic glands were removed.

TABLE II—SURGICAL SUBGROUP A

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Dead and cause
	Belt	—	T	++	9 mos. Lung metastases
2	M. Ishi	—	S	++	Dead
3	M. Ishi	—	S	++	Dead
4	Cahill	—	—	++	
5	Cahill	—	—	++	†
6	MacGowan	—	—	++	Short time after operation
7	Young (4140)	—	—	++	3 mos. Metastases to abdomen, lung
8	Olsen	—	T	++	4 mos.
9	Sullivan	—	T	++	1 mo.
10	Terry	—	T	++	†
11	Meads	—	—	++	Several wks. after operation
12	Meads	—	—	++	Several wks. after operation
13	Ravensel (Negro)	—	S	++	3 mos.
14 to 19	Mark (5 cases)	(X-ray and radium)	—	++	All dead within 1 yr.
20 and 21	Kivellman (2 cases)	—	—	++	Both dead. Lung metastases.

T—teratoma; S—seminoma.

Result, living and well last report, 3 1/2 yrs.

†Result, living and well last report, not stated.

‡Result, lost.

initial metastasis is the real factor back of the 11 cures. Thirteen or 50 per cent, are alive and well 4 years and longer.

In 41 of these 80 cases metastases to pre aortic lymph nodes were found, in 7 seminomata and 24 teratomata (type not stated in 10). There is the one surgical death of the whole series in this group 10 days after operation, of pneumonia. Twenty three of the 41 cases have since died of metastases the majority within 1 year, 17 are living 6 of these 5 years or more (2 seminomata, 1 not stated, 3, teratomata). If teratomata are really and always radioresistant, then these 3 cures are directly attributable to successful radical resection of the pre-aortic lymphatics.

The series of 100 cases are summarized in Table V. Of the 80 cases "successfully" operated upon 35 per cent are dead of metastases and 63.75 per cent are living of which 17 cases or 20.1 per cent are cured (alive and well 5 years or longer).

The results of orchidectomy with or without radiation. In answering the questions about radical

TABLE III—SURGICAL SUBGROUP B

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Result
					Living and well last report
1	Elewiler	11-20-14	S	None	1917 8 yrs.
2	Hepler	1915 (Deep X-ray for 1 yr.)	S	None	†
3	Olsen	2-16-18	T	None	10-10-31 4 yrs 8 mos.
4	Gilson	—	T	None	Oct., 31 27 mos.
5	Kuterman	2-11-18	T	None	10-31-31 3 yrs 9 mos.
6	Hyman	—	S	None	†
7	Patch	1914	T (carcinoma)	None	Nov. 31 7 yrs.
8	Patch	1917	Embryoma with tuber culoids	None	Nov. 31 4 yrs.
9	Wear	—	T	None	8 yrs.
10	Wear	—	T	None	6 yrs.
11	Sargent	—	S	None	11-5-31 yrs.
12	Krammow sky	9-30	T	None	10-30-31 1 yr.
13	Barringer	—	T	None	ee
14	Barringer	—	T	None	ee
15	Barringer	—	T	None	ee
16	Barringer	—	T	None	ee
17	Belt	—	T	None	††
18	Wagenersten	2-17-20	T	None	8-20-31 6 1/2 yrs.
19	Cahill	—	—	None	4 cases alive and well up to 6 yrs., subgrouping not stated. 1 Case not seen or heard from in 3 yrs.
20	Cahill	—	—	None	
21	Cahill	—	—	None	
22	Cahill	—	—	None	
23	Young (4140)	—	—	None	††
24	Young (7000)	—	—	None	4 1/2 yrs.
25	Keyes	—	—	None	Not followed
26	Keyes	—	—	None	Not followed
27 to 33	Lowmley	—	—	None	7 cases Not stated

T—teratoma; S—seminoma.

Before introduction of radium.

† None of the three patients following operation or at any time were unusually ill. I have heard this operation described as "frank butchery". My experience with it would indicate that it is purely an anatomical operation and that it can be done with no great difficulty.

††Death: 193. Cause: Glads above (1 yr.) renal pelvis.

††Death: 10 mos.; Cause: Intra-abdominal metastases.

††Death: 10 mos.; Cause: Metastases.

††Death: 1 yr.; Cause: Abdominal metastases.

ee, Lost.

TABLE IV—SURGICAL SUBGROUP C

Case No.	Surgeon	Date of radical operation	Type of tumor	Lymphatic metastases	Result	
					Dead and cause	Living and well last report
	Heyler	June, 32	S	—		1937—over 3 yrs
	Gibson	8-1-33	T	—	6 mo.	
	Foley	30	S	—		2-6-33, 3 yrs
	Ferguson	Feb. 33	S	—	3 yrs. Metastasis	
1	Ferguson	Dec. 33	S	+		Sept. 33, 3 yrs
2	Patck	3-4	T	—	8 mos. Metastasis	
3	Wear	—	T	—		3 yrs
4	Hess	—	T	—	yr. Metastasis	
5	Hess	—	T	—	yr. Metastasis	
10	Wright	—	T	+	6 mos. Lung metastasis	
	Sargent	—	S	—		—3-3 still convalescing
	Powell	—	T	—	yr.	
	Powell	—	T	—	yr.	
	Whitty	—	T	—	days. Pneumonia	
	Whitty	—	T	—	5 mos.	
	O'Connor	—	T	—	7 mos. Metastasis	
7	O'Connor	—	T	+	mos. Metastasis	
	O'Connor	—	T	—	mos. Metastasis	
9	Calby	-6-33	Embryonal cart.	+		Nov. 30-33 has metastasis in bone
10	Calby	—	Embryonal cart.	—	mos. Unassociated with metastasis	
11	Belt	—	T	—	Dead. Lung metastasis	
	Belt	—	T	+	Dead. Spinal cord metastasis	
13	Quarner	10-34	Embryonal cart.	—	2-8-35 Cervical gland metastasis above of horn's eye	
14	Wangsten	4-9-35		+	Oct. 1935 Liver and gland metastasis	
15	Wangsten	8-8-35	Not stated	++		Convalescing
16	Callie	—	Not stated	—	yr. Lung metastasis	
17	Callie	—	Not stated	—	yr. Lung metastasis	
18	Young (9133)	—	Not stated	—		9 yrs
19	Young (915)	—	Not stated	++	yr. Abdomen and lung metastasis	
20	Young (1934)	—	T	+	3 mos. Lung and liver metastasis	
21	Young (13)	—	Not stated	+		yr.
22 to 24	Levensky 3 cases	—	Not stated	+		Not stated
25	MacGowan	?	Sarcoma (S)	+		no yrs.
26	Ferguson	—	S	Not stated		6-11-35
27	Barney	—	? (Lab. report lost)	?		Made good recovery from operation, lost from observation
28	Young (963)	—	Not stated	Not stated		yr.

See footnotes on opposite page.

TABLE V—SUMMARY BY SURGICAL GROUPS OF ONE HUNDRED CASES OF RADICAL SURGERY BY AMERICAN SURGEONS (INCLUDING TWELVE PERSONAL)

		Operative deaths	Died of metastases	Living		
				Not stated	Under 5	Over 5
Group A—Found to be inoperable	Seminoma	3	None	—	—	—
	Teratoma	4	None	1	—	—
	Not stated	15	11	—	1	—
		20	17	1	1	—
Group B—No metastases found in tissues removed	Seminoma	4	None	—	1	1
	Teratoma	17	None	4	5	6
	Not stated	15	1	9	1	4
		36	5	15	7	11
Group C—Metastases found and removed presumably completely	Seminoma	7	None	—	3	2
	Teratoma	14	1-2 days of pneumonia	1	1	3
	Not stated	1	None	3	3	1
		41	1	4	7	6
Type of tumor and metastatic findings whether one stated	3	None	0	1	—	—
Total	80	1	25	18	16	27
Per cent			25	4.5	6.75	20.1

Total operations, Groups A, B, C, 100
Operative deaths, 1

surgery submitted by letter to American urologists, the following facts relative to results following simple castration with or without pre-operative and postoperative radiation were obtained. About 258 cases are listed in Table VI which gives the source of the information and the results, which are summarized in Table VII. Of the approximate 258 cases, 118 are dead, 124 are living but only 17 for 5 years or longer, a cure of only about 6 per cent.

Five year cures of abdominal metastases by deep X ray. The Cancer Commission of the California State Medical Society has been actively at work for some time. Recently, two subcommittees sent out to all members of the Radiological Society and of the western branch of the American Urological Association the following question:

Have you seen 5 year cures following radiation treatment of abdominal lymph gland metastases in testicular tumors? Six radiologists replied in the affirmative listing more than 12 cases and 10 urologists said yes, listing 23 cases giving the very encouraging total of 35 cures by radiation of cases hopeless from a surgical standpoint. The radiological committee chairman and the urological committee chairman have very kindly given me the names of the doctors reporting these cases

and, in order that the record be one of fact and not one of shrewd inference, each one has been written for details regarding the cases observed by him. The result, summarized in Table VIII, is very disappointing showing a probably authentic cure in only 3 cases but these 3 cases prove that certain types of testicular tumor are very radiosensitive and that deep X ray therapy can cure some cases which are absolutely hopeless otherwise.

SUMMARY

It is illogical to compare on their face value the different series of cases mentioned. That is not the present purpose. Rather is it a desire to determine whether radical operation is ever a justifiable procedure. The results of the 80 radical operations have the advantage in comparison over those of simple orchidectomy of being a selected group—cases in which no clinical evidence of metastases could be found—and a fair comparison would be with a similar selected series treated by simple orchidectomy. The results as presented, however are summarized for comparison in Table IX, showing 17 cures in 80 cases of radical surgery with one operative death as against 17 cures in 258 cases of orchidectomy without an operative death. Indisputable evidence

T—teratoma, S—seminoma.

* Of 9 cases, 1 had radical operation and all the other 7 died within 1 year.

† Subgrouping not stated.

‡ My impression is that all the lymph nodes were probably involved, but repeated examination failed to reveal any involvement because of previous X-ray treatment.

§ Testicles removed together with skin of scrotum, adjoining skin of thigh and lower abdomen and accompanying lymphatics, cord and spermatic vessels up to the hilum of the kidney and down to the apex of the vas.

¶ Given X-ray previous to operation and pathologist unable to find evidence of malignancy in testis or glands after radical removal.

TABLE VI.—ORCHIDECTOMY CASES

No.	Name	Date	Radiation		Type of tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Last	Well
1a to 4	Copbridge	Not given		3	T	at home at not mentioned	6 mos. Not given		7 yrs 1 yrs.
8 to 9	Cremming	Not stated			T	3 yrs 5 mo	1 dead. Not given		cure, time not stated 3 yrs.
20	Bucher	2-6-28		Yes	T	Not stated			1 1/2 yrs.
30 to 31	Cecil	Not stated		Yes	T	Not stated	1 6 mos. Not given		37 11 6 mos.
14 and 15	Herrick	Not stated			2. "embryonal carcinoma"	no not stated	9 mos metastasis		3 yrs.
8 to 20	Blumgartner	Not stated		Yes	T	Not stated			21 1/2 yrs.
and 21	McLennan	-26-26 4-13-29	Yes	Yes	"Embryonal carcinoma" T	3 No	6 mos. Generalized metastasis		7 mos.
22 to 23	Curl	Not stated			S	Not stated			no difficulty data not given
26 and 27	Parfles	Not stated		Yes	"Embryonal carcinoma" T	No No			21 6 mos.
28 and 29	Patterson	Not stated	Yes		T	Not stated			
30 to 32	Parmenter	April, 1921 8-2-29 8-27-30 8-24-31			S S S S	Not stated Not stated Not stated Not stated			9 plus years 14 years 17 plus year month
33 to 37	Fordis	Not stated			T "Embryonal carcinoma"	Not stated			5 years 12 years 2 years 1 6 months 1 month
38 to 40	Fowler	7-12-30 2. Not stated		Yes 2 not stated	S 2. not stated	Not stated	3 dead. Metastasis		36 years 12 years 4 months 21 had late metastasis time not stated
47 and 48	Wade	Not stated	Yes	Yes	T	Not stated	dead Metastasis (1 met., 1 T)		
50 to 51	Ormond	Not stated			S	Not stated			33 mos 11 3 years
52 to 53	Wood	Not stated		Yes	at T 1 S	Not stated	(T) d. 6 mos.		1 (T) 11 mos. 2 (S) Living, 1934 and 1941
56	Reyns	Not stated			T				Good result
57 to 59	Schell	-23-29 8-13-30 8-4-30	Yes Yes Yes	Yes Yes Yes	T T S				27 years 17 years 27 6 mos
60 to 61	Karsten	Not stated			T (2)		dead. Metastasis		Living and well

T—teratoma; S—sarcoma.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of Tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
64 and 65	Morton	Not stated		Yes	Not stated		11 3+ yrs. Abdominal metastases		1 10 months
66	McCune	Not stated			T		11 3 yrs. Brain metastases		
67	Edison	Not stated			T				1 3 1/2 yrs.
68	Van Deburg	7-1-38			S				11 3 1/2 yrs.
69	McKay	Not stated		Yes	T				11 3 yrs.
70	B. W. Turner (3 other cases)	Not stated (not included because not operated upon)			Mixed (all types)				1 3 yrs.
71 to 73	Rakch	Not stated			1 T 2 Car 3 corn		1 dead. Recurrence		1 10 yrs?
74 to 78	Backus	Not stated			1 T		5 dead. { 1 nec. cause? 1 3 1/4 yrs Metastases		
79 to 83	Hennessey	Not stated		Yes (6) 1 Not stated	6 Embryonal carcinoma 2 Carcinoma 3 Carcinoma 5 Carcinoma 5 Carcinoma		dead. (4 and 5 non-metastatic)		1 3 yrs. 1 3 1/4 yrs. 1 3 1/4 yrs. 1 3 yrs. 11 Carcinoma just discharged from hospital
(3 other cases not included because of lack of information)									
86	McNulty	Not stated			S		1 dead, refused radical removal of lymph nodes and left hospital		
87	Ferguson	June, 01			S				11 5 mos.
88 to 90	Vander Veer	9-0-38 1 Not stated	4 Yes 1 Not stated	2 Yes 1 Not stated	3 T		1 6 mos. General metastases		11 3 yr. 1 3 yrs.
91 and 92	Oben	1 4-3-31 1		1 Yes	1 Carcinoma 1 T	1 Yes	1 8-1-31 (4 mos.) General metastases 11 3 mos. Local infection prevented radical operation. Patient returned later but died of metastases before radical operation was performed		
93 to 98	O'Connor	Not stated			6 T				11 8 yrs. 11 7 yrs. 11 4 yrs. 11 Not stated
99 to 103	McKernan	Not stated			7 T			1 Lost	1 4 yrs. 11 3 yrs.
104 to 130	Lewis (45 traced cases)	14. dates? 17 dates?	7 Yes 13 Yes 3 radium only	7 Yes 13 Yes	16: T 16: S		1 dead	1 Lost after 1 yr (T)	Of 16 T 9. 1-3 yrs. 10. 3-4 yrs. 11. 3-5 yrs. 12. Not stated Of 49 S 13. 1-3 yrs. 14. 3-4 yrs. 15. 3-5 yrs. 16. 10 yrs.
131 to 136	Bart	9 Dates?	Yes	Yes	Not stated		6: Cause not stated		11 3 yr. 11 3 yrs. 11 3 yrs.
136 to 167	Orring	+					6: Cause not stated		11 3 yrs.

—Teratoma; S—sarcoma.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
148 to 174	Doming	+			T S		p. Within 24 mos.		22 2 yrs. 11 4 yrs.
175 and 80	Struben	+					4 mos.		9 mos.
1 to 41	Finckelman	+			T S		1 (1, 37 4, 14 27 2, 6 mos.)		
14 to 56	Dillingham	+					1 (6 to 6 mos.)		
7	Rutter	+					All dead: metastases to lung and retroperitoneal glands		
1	Devine	+	Yes	Yes			All dead		
2+	Schroeder	+			T S		All dead		
3+	Prusack	+					All dead		
+	Gierck	+	X-ray		T				1 37 4 yrs.
	Greene	+					All within yrs.		
+	Kirsch	+					Metastasis		
7	Howes	+			Major by T		Thous followed all dead		
2+	Burns	+		X-ray			non. Pulmonary metastases (X-ray)		
2+	Fischel	+					All dead		
+	Revered	+			S		several mos.		
	Aden	-		Deep X-ray					21 37 14 yrs.
7	Johnston	+		X-ray			All dead		
67	Crockett	+					All dead		
4+	Carroll	+			1 T S		37 3 yrs.		
7+	Barnard	+					All within yrs.		

T—teratoma; S—sarcoma

TABLE VII.—ORCHIDECTOMY WITH OR WITHOUT RADIUM AND X RAY

Cases	Simultaneous	Tumors	Not treated	Total
Pre-operative radiation	79	97	81	255
Post-operative radiation	—	20	—	—
Patients dead	14	55	15	—
Patients lost	20	51	67	138
Patients lost	1	12	3	16
Result—not stated	7	7	—	14
Living—1 year	27	23	7	57
Living—2 years	3	2	8	13
Living—3 years	14	9	3	26
Living—4 years	1	1	—	2
Living more than 5 yrs.	4	11	—	15

Total living 124 or 48.4 per cent.
Cured 4.0 per cent.

of the value of radical surgery is given by the cure of 3 cases of radioresistant teratomata in which

TABLE IX.—SUMMARY

	Cases	Dead	Not stated or lost	Living	
				Under 5 years	Over 5 years
I Radical operation	26	29	25	16	1
II Orchidectomy with or without radiation	25	218	26	62	27
III Five year course of subcutaneous lymph gland metastases	25	—	—	—	3

TABLE VIII.—FIVE YEAR CURES OF ABDOMINAL LYMPH GLAND METASTASES IN TESTICULAR TUMORS BY DEEP X RAY

Summary of replies to the California State Cancer Commission questionnaire dated September 14 1932

Affirmative radiologists, 6	Cases	Reply to request for details of these cases		
		Date	Summary	Confirmed
Zimmerman	A few	10-6-32	Have seen no 5 year cures not even a 3 year cure "	
Ruggles and Bryan	5	9-30-32	Only 1 case "Julius Kohn," case of Dr. Henry Harris, bilateral tumors first, deep X-ray 1926, abdominal masses appeared in 1930, second deep therapy now living and well	6 years
J. Lavitkin	1	0-32	Case "Julius Kohn," same as above	
4. Taylor	1 Irving 3 years		No reply	
5. Soland, Costelow and Meland		9-14-32	One case now being nearly 9 years and still well. No details	9 years
6. Dr. Kline	12+		No reply	
Affirmative radiologists, 10			(Dr. Mathé, chairman letter dated September 10, 1932)	
1. Parker	12		No reply	
2. Reiche		10-6-32	Dr. Mathé must have misunderstood me have not had a 5 year cure "	
3. Mathé			No reply	
4. Wesson			Reported in Am. J. Surg. 1927 Case 1 A. W., Orchiectomy Feb. 9, 1, abdominal metastasis, 1924. 5 to 20 inguinal glands removed. X-ray by Dr. Reiche. "Apparently well," 1927. Type of tumor not stated	5 years
5. Jones		8-16-32	"Orchiectomy 1915. Now dead, apparently of lung and abdominal metastases	
6. Scholl		8-29-32	Vaguely recollect seeing two cases at Mayo Clinic	
7. Willard		Telephone 0-4-32	"Seen a long time ago, records at St. Luke's Hospital	
8. Davis		David M. Phoenix 9-14-32 John R. Denver 9-17-32	"Mistake, not seen a case "Do not recall such a case	
9. Gibson		8-16-32	"Misunderstood. Have seen no cases "	
10. Ingber		8-27-32	"No record of such a case and none seen by associates, Rodenbaugh and Kile "	

metastatic glands were removed surgically. It must be conceded that without radical surgery these patients must have died of metastases.

CONCLUSION

1. The radical operation for tumor of the testis is indicated in cases without clinical evidence of metastasis in which after orchiectomy the pathologist reports a mixed type tumor.

2. The surgical risk of the operation in the hands of American surgeons is about 1 per cent, a perfectly justifiable risk in view of the high morbidity following simple castration and X ray

3. The fact that at least 3 of 24 otherwise hopeless cases (24 teratomata with lymph metastases removed) have been cured by the radical operation proves its possibilities.

4. The fact that half of the cases (18 of 36) in which the pathologist could find no evidence of metastasis in the gland tissues removed are living (4 years or longer) indicates that radical surgery is preferable to simple castration even in these cases, and the surgeon should not feel that radical resection was unnecessary even though the pathologist tells him that he has removed no metastatic cancer.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of tumor	Clinical metastases	Result		
			Pre	Post			Death Date and cause	Lost	Well
166 to 178	Doming	+			T S		9 Within 15 mos.		1 3 yrs. 11 4 yrs.
178 and 180	Struben	+					2 8 mos.		11 9 mos.
181 to 183	Paluchman	+			T S		1 (6 yr. 4, 13/4 yr. 6 mos.)		
184 to 186	Dillingham	+					3: (6 to 8 mos.)		
?	Kotter	+					All dead: metastases to lung and retroperitoneal glands		
?	Devine	+	Yes	Yes			All dead		
2+	Schneider	+			T S		All dead		
2+	Peacock	+					All dead		
2+	Gerbick	+	X-ray		1 T				2 yrs. 4 yrs.
?	Green	+					All within yrs.		
+	Cherk	+					Metastases		
?	Hunter	+			Major- S2 T		Thous. followed all dead		
+	Bern	+		X-ray			non Pulmonary metastases (X-ray)		
2+	Flach	+					All dead		
+	Kennel	+			S		1 several mos.		
	Allen	-		Deep X-ray				2 yr. 14 yrs.	
?	Johnson	+		X-ray			All dead		
2+	Cherkatz	+					All dead		
+	Carroll	+			1 T S		7 yrs. 5 Wks.		
2+	Beard	+					All within yrs.		

T—teratoma S—sarcoma

TABLE VII.—ORCHIDECTOMY WITH OR WITHOUT RADIUM AND X RAY

Cases	Benign	Teratoma	Not stated	Total
Pre-operative radiation	79	97	83	259
Post-operative radiation	14	55	3	72
Patients died	30	37	67	134
Patients lost	1	3	3	7
Result—not stated	7	7	—	14
Living—1 year	27	25	7	59
Living—1 years	8	1	2	11
Living—3 years	14	9	3	26
Living—4 years	1	1	—	2
Living more than 5 yrs.	6	11	—	17

Total living 124 or 48.4 per cent.
Cured 6.0 per cent.

of the value of radical surgery is given by the cure of 3 cases of radioresistant teratomata in which

TABLE IX.—SUMMARY

	Cases	Dead	Not stated or lost	Living	
				Under 5 years	Over 5 years
I. Radical operation	60	29	15	16	17
II. Orchidectomy with or without radiation	258	173	30	20	17
III. Five year term of abdominal lymph gland metastases	25	—	—	—	1

TABLE VIII—FIVE YEAR CURES OF ABDOMINAL LYMPH GLAND METASTASES IN TESTICULAR TUMORS BY DEEP X RAY

Summary of replies to the California State Cancer Commission questionnaire dated September 14 1932

Affirmative radiologists, 6	Cases	Reply to request for details of these cases		
		Date	Summary	Confirmed
1. Zimomman	A few	10- 6-32	Have seen no 5 year cures nor even a 3 year cure "	
2. Ruggles and Bryan	3	9-20-32	Only 1 case Julius Kahn, case of Dr Henry Harris bilateral tumors, first, deep X-ray 1928 abdominal masses appeared in 1930, second deep therapy now living and well	6 years
3. Levithin	1	10- 1-32	Case "Julius Kahn," same as above	
4. Taylor	1 "Living 3 years"		No reply	
5. Sedgwick, Cortikow and McIsaac	1	9-14-32	One case now being nearly 9 years and still well." No details	9 years
6. Dr. Kelsey	$\frac{2}{12+}$		No reply	
Affirmative urologists, 10			(Dr. Mathé chairman, letter dated September 19 1932)	
1. Parker			No reply	
2. Reiche		10- 6-32	"Dr. Mathé must have misunderstood me have not had a 5 year cure."	
3. Mathé	1		No reply	
4. Wessons			Reported in Am. J. Surg. 1932 Case 1 A. R., Orchiectomy Feb. 9 1928 abdominal metastasis, 10 4, 15 to 20 inguinal glands removed X-ray by Dr. Reiche. "Apparently well, 1932 Type of tumor not stated	5 years
5. Jones		8-16-32	Orchiectomy 1925. Now dead, apparently of lung and abdominal metastases	
6. Scholl		8-20-32	Vaguely recollect seeing two cases at Mayo Clinic	
7. Wilford		Telephone 10- 4-32	"Seen a long time ago, records at St. Luke Hospital	
8. Davis		David M. Phoenix 9-14-32 John B. Denver 9-27-32	"Mistake, not seen a case" "Do not recall such a case"	
9. Gibson	1	8-16-32	"Misinformed. Have seen no cases"	
10. Ingber	1	8-27-32	"No record of such a case and none seen by associates, Rodenbaugh and Kile"	

metastatic glands were removed surgically. It must be conceded that without radical surgery these patients must have died of metastases.

CONCLUSION

1. The radical operation for tumor of the testis is indicated in cases without clinical evidence of metastasis in which after orchiectomy the pathologist reports a mixed type tumor.

2. The surgical risk of the operation in the hands of American surgeons is about 1 per cent, a perfectly justifiable risk in view of the high morbidity following simple castration and X ray

3. The fact that at least 3 of 24 otherwise hopeless cases (24 teratomata with lymph metastases removed) have been cured by the radical operation proves its possibilities.

4. The fact that half of the cases (18 of 36) in which the pathologist could find no evidence of metastasis in the gland tissues removed are living (4 years or longer) indicates that radical surgery is preferable to simple castration even in these cases, and the surgeon should not feel that radical resection was unnecessary even though the pathologist tells him that he has removed no metastatic cancer.

TABLE VI.—ORCHIDECTOMY CASES—Continued

No.	Name	Date	Radiation		Type of Tumor	Clinical metastases	Result		
			Pre	Post			Depth Date and cause	Last	Wall
146 to 148	Dowling	+			T S		9 Within 20 mos.		11 3 yrs. 12 4 yrs.
178 to 180	Brown	+					6 mos.		1 9 mos.
8 to 32	Polachman	+			T S		3 (1, 37 1, 36 yr 1, 6 mos)		
84 to 86	O'Dayton	+					1 (6 to 8 mos)		
1	Kuter	+					All dead; metastases to lung and retroperitoneal glands		
1	Deems	+	Yes	Yes			All dead		
1+	Schmorrow	+			T S		All dead		
1+	Peacock	+					All dead		
1+	Gurlick	+	X-ray		T				1 3 yrs. 4 yrs.
1	Grant	+					All within 3 yrs.		
+	Kerich	+					Metastases		
1	Bunker	+			Major by T		Thrombosed all dead		
1+	Brown	+		X-ray			non Palmarium metastases (X-ray)		
1+	Fachal	+					All dead		
1+	Barwood	+			S		1 several mos.		
	Allen	-		Deep X-ray					37 16 yrs.
1	Johnson	+		X-ray			All dead		
41	Cochett	+					All dead		
+	Carroll	+			T S		37 5 mos.		
1+	Reynold	+					All within 3 yrs.		

T—teratoma; S—sarcoma

TABLE VII.—ORCHIDECTOMY WITH OR WITHOUT RADIUM AND X RAY

Cases	Teratoma	Teratoma	Not stated	Total
Pre-operative radiation	70	0	82	258
Post-operative radiation	14	13	18	—
Patients dead	80	3	67	118
Patients lost	1	12	3	6
Result—not stated	7	7	—	14
Living—1 year	37	25	7	100
Living—2 years	3	1	4	8
Living—3 years	4	0	2	26
Living—4 years	1	1	—	2
Living more than 5 yrs.	6	11	—	17

Total living 124 or 48.4 per cent.
Cured 6.6 per cent.

of the value of radical surgery is given by the cure of 3 cases of radioresistant teratomata in which

TABLE IX.—SUMMARY

	Cases	Dead	Not stated or lost	Living	
				Under 5 years	Over 5 years
I. Radical operation	80	29	18	26	17
II. Orchidectomy with or without radiation	258	118	20	23	17
III. Five year cases of phallosarcoma, orchid gland metastases	15	—	—	—	1

Mrs. W., operated upon 3 years after the beginning of her symptoms on March 7, 1921 at the age of 70 years. Her tumor was described by the physician who referred her as follows "There is a large growth on the left lateral wall which shows two or three bleeding points, and a large area of ulcerated surface which is covered with a shaggy layer of fibrinous exudate. This tumor is hard and nodular and involves left ureter. It is undoubtedly malignant and absolutely inoperable with any hope of future comfort to patient. At operation I found a tumor "covering the left angle of the trigone and adjoining base, about 4 by 2 centimeters in size and raised about 5 millimeters." Glass tubes of radium emanation amounting to 633 millicurie hours were implanted and two capsules of silver screened emanation left in the bladder the radiation from which was estimated at 490 additional millicurie hours. No attention was paid to a small secondary papillary tumor in the urethra. A small specimen was taken and found to be carcinoma, many years later graded as II. Postoperative radium irritation lasted about 3 weeks and it was 3 weeks before the suprapubic wound was healed. Cystoscopy at various periods up to 3 years after operation showed no return of the tumor. When last heard from in 1931 at the age of 82 years, 10 years after operation patient was quite senile but had normal bladder function and no recurrence.

Since 1925 with the exception of an occasional resection, my bladder cancers have been treated by implantation of so called seeds of gold or platinum varying from 1 to 25 millicuries of radium emanation. In my records previous to 5 years ago I find 69 cases of bladder cancers proved microscopically. Forty seven were treated by radium emanation implantation and 17 (36 per cent) of these have survived 5 to 10 years (alive and well excepting one who died following a negative exploration of his abdomen by another surgeon). The remaining 22 treated by other—presumably curative—procedures show a 10 per cent 5 year survival.

SUMMARY

The cases cited illustrate the fact that cancer in this generation like tuberculosis in the preceding one, is becoming each year more and more a curable disease.

MALIGNANCY OF CEREBRAL TUMORS

WINCHELL McK CRAIG M.D., F.A.C.S., ROCHESTER, MINNESOTA

Section on Neurologic Surgery The Mayo Clinic

TUMORS of the central nervous system have been diagnosed more accurately and treated more effectively as the result of the methodical pathological analysis instigated by a small group of investigators who realized the necessity of classifying these tumors with regard to their relative malignancy.

This more careful analysis has amplified our knowledge of all tumors of the central nervous system, and particularly of tumors of the brain. These tumors produce definite symptoms which, however, may also be caused by other intracranial lesions, such as aneurisms, abscesses, subdural hematomata, traumatic cysts and inflammatory conditions such as arachnoiditis involving either the cisterna cerebello-medullaris, the optic chiasm or the cerebral hemispheres.

The entire group of brain tumors consists of pituitary adenomata, meningeal fibroblastomata, acoustic neuromata, congenital tumors such as craniopharyngeal pouch cysts and dermoids, metastatic tumors, granulomatous tumors of syphilitic or tuberculous origin, angioblastic tumors, and gliomata.

The gliomata arise from the substance of the brain; they comprise only 40 per cent of all intracranial tumors and were formerly considered incurable.

Within the last decade, these tumors have been analyzed pathologically and clinically by Bailey and Cushing, Penfield, Globus and Strauss, Roussy, Greenfield, Kernohan, and others, and due to their efforts, definite order has emerged from the chaotic condition which previously existed. Tumors of the glioma group are no longer considered as having all the same degree of malignancy or as giving all the same prognosis, and this of course influences the surgical attitude. The tumor can be classified at the time of operation, and if its removal is feasible the operation can be planned in one or more stages, as indicated by the condition of the patient.

All tumors, regardless of their cellular nature, vary in malignant potentialities, and we are all familiar with the grading from 1 to 4 of malignant tumors which is based on cellular differentiation and which proves of great assistance in deciding on a surgical program as well as indicating the probable postoperative longevity.

Brain tumors of the glioma group are malig-

nant in that they invade the surrounding structures and tend to recur but do not metastasize to other parts of the body. They have been analyzed clinically and pathologically in a manner similar to cancer elsewhere in the body. However, instead of attempting to grade their respective malignancy based on the amount of cellular differentiation, they have been classified and tabulated according to the predominating cellular structure. The cells arising from the primitive medullary epithelium take on the characteristics of different types of cells, as development progresses toward adult and mature glial structures. These transitional cells have been designated spongioblasts, medulloblasts, astroblasts, and astrocytes. Tumors composed predominatingly of these cellular structures have been classified as spongioblastomata, medulloblastomata, astroblastomata, and astrocytomata. Other cells which may produce tumors are the oligodendrocytes and the ependymal cells.

Consequently the nomenclature of gliomata thus evolved consists of such descriptive terms as spongioblastoma multiforme and polar spongioblastoma, medulloblastoma, ependymoma, and so forth. For the purpose of convenience, I am using only 7 of these divisions to illustrate the relative malignancy of these tumors and the distinct clinical and surgical advantage of their classification. These groups are being constantly changed, new names being added and old names discarded, as analysis of the gliomatous tumors becomes more nearly universal and better understood.

The tumors which could be pathologically classified under spongioblastoma multiforme, medulloblastoma, astrocytoma, oligodendroglioma, astroblastoma, polar spongioblastoma, and ependymoma form the basis of this report, although there are other smaller groups into which some of the gliomata can be divided.

Of these, the spongioblastoma multiforme and the medulloblastoma rank as the most malignant and would compare favorably with a carcinoma graded 4 elsewhere in the body. The average periods of survival of patients who have these tumors has been given as 12 and 17 months, respectively, making the possibility of a 5 year cure very remote. Fortunately these two groups comprise only 41 per cent of the total group of gliomata. There is a distinct difference between these two

groups and the remaining divisions, because in all of the five remaining groups it has been possible to trace 5 year cures. The astroblastoma, the ependymoma, and the polar spongioblastoma can be grouped together with regard to their malignant potentialities, and would correspond to tumors elsewhere in the body of malignancy, graded 2. The astroblastomas represent 2 per cent of the gliomata, the polar spongioblastomata, 7 per cent and the ependymomata, 4 per cent, which gives a total of 11 per cent for this intermediate group. The average period of survival of patients who have such tumors is 28, 32, and 46 months, respectively.

The last combination of these pathological groups comprise the oligodendrogliomata and the astrocytomata, the cellular structure of which indicates malignancy of low grade, they would correspond in malignancy to carcinoma graded 1 elsewhere in the body. The astrocytomata comprise 27 per cent of the gliomata and the oligodendrogliomata 18 per cent in all 45 per cent this is a greater proportion than that of tumors corresponding to grade 4. The average period of survival of patients who have astrocytoma has been given as 66 months and of those who have oligodendroglioma as 76 months.

Thus, it is apparent that investigation has completely changed the clinical and surgical attitudes toward intracranial gliomata, inasmuch as they have been found to comprise only 40 per cent of intracranial neoplasms, and of this 40 per cent less than half fall into a group analogous to carcinoma graded 4 elsewhere in the body. About half the gliomata can be compared to tumors of malignancy graded 1 elsewhere in the body and about 11 per cent can be compared with tumors graded 2.

Operability and prognosis concerning gliomata depend not only on their cellular characteristics, but also on their situation within the brain, on the invasion of surrounding tissue and on the permanent injury which has resulted from pressure. In view of these facts, I have taken for analysis concerning 5 year cures only those patients who have remained relieved of symptoms over this period, and who have been able to return to work without any apparent aberration of function.

Five year cures followed total removal of tumors in all groups except those composed of spongioblastomata and medulloblastomata. In these two groups relief was only palliative and temporary. Five year cures resulted in the group composed of astroblastomata, following total removal of tumors at the primary operation, sub-

total removal followed by radiotherapy, and subtotal removal followed in 2 or more years by total removal at secondary operation. Five year cures resulted in the group composed of polar spongioblastomata following total removal of the tumor at the primary operation, total removal by means of three operative procedures at intervals of 2 years, subtotal removal followed by roentgen treatment, and removal of mural nodules in cystic tumors. Five year cures resulted in the group composed of ependymomata following total removal at the primary operation or in multiple stages, as well as subtotal removal with subsequent treatment by radium. Five year cures resulted in the group composed of oligodendrogliomata following total removal at the primary operation and subtotal removal in two or three operations separated by intervals of from 1 to 3 years, and 1 patient was well for 5 years following decompression and one treatment with radium. Five year cures resulted in the group composed of astrocytomata, from total removal at the primary operation, from total removal following three operations, and from subtotal removal followed by treatment by means of roentgen rays and radium.

A review of the 5 year cures emphasizes the fact that more careful pathological analysis has been invaluable in classifying the tumors of the glioma group with regard to their operability and response to irradiation. In dealing with the most malignant group, comprising the types known as spongioblastoma multiforme and medulloblastoma treatment can be only palliative even when apparent total removal is followed by radiotherapy.

Tumors of the remaining groups, which are less malignant, have responded to one or more surgical procedures and irradiation with resulting 5 year cures. It is rather difficult to estimate the value of treatment by radium and roentgen rays in treatment of these tumors at the present time, because in most of the cases in which 5 year cures occurred radiotherapy was given at some time during the period of treatment. Repeated operations on the less malignant types of glioma have been followed by 5 year cures so consistently that it has become the treatment of choice, depending of course on the condition of the patient and the amount of permanent injury which has been produced.

It is apparent, therefore, that gliomata comprise only 40 per cent of intracranial tumors, and are not all hopelessly malignant. It is true that the more malignant tumors can be treated only palliatively, by operation and irradiation,

but the classification and analysis of this group of tumors have emphasized the fact that some of the more benign types respond to treatment so successfully that complete relief of symptoms fol-

lows one or more operations, and tumors of the entire group are not only receiving more efficacious treatment as time goes on but more permanent cures are being realized.

LARYNGEAL CANCER

STATISTICAL REPORT ON FIVE YEAR CURES

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LARYNGEAL cancer may be intrinsic or extrinsic. The surgical treatment (laryngofissure) in early intrinsic cancer of the larynx yields a more striking and lasting result than can be claimed in any other internal region of the body the lymphatic arrangement is to a marked degree confined metastasis is therefore, late. About 80 per cent cures is the reported results of experienced operators.

I have performed the operation of laryngofissure on 10 patients, with the following results:

The first patient, who died of recurrence, should have had a total laryngectomy. Four are free from any evidence of recurrence after more than 5 years: 1 11 years 8 months; 1 9 years 4 months; 1 5 years 7 months; 1 5 years and 2 months. The remaining 5 cases have not quite reached the 5 year period since operation, but are still free from recurrence.

Our records show that in the group of advanced

intrinsic cancer in which total laryngectomy was performed, there are 83 cases: 52 or about 63 per cent, are living and remain free from the disease. Of the 52 living cases, 32 have passed the 5 year cure period the longest period being 11 years since the operation.

In extrinsic cancer of the larynx with varying degrees of cervical lymphatic metastasis, extension to the tongue pyriform sinuses and esophagus, which only a few years ago were considered hopeless are now promised a brighter future. In this group, we have operated upon 75 patients: 16 or slightly over 21 per cent, are living and enjoying life free from the disease beyond the 5 year period—the oldest in point of operation, being 12 years.

One patient with squamous cell carcinoma of the epiglottis is living and well after 7½ years following a subhyoid pharyngotomy. In all cases the diagnosis was confirmed by biopsy.



Fig. 1.



Fig. 2.



Fig. 3.

Fig. 1. Early epithelioma of the right vocal cord. Note the infiltrating type of lesion with inflammation of the cord. In this type of case 80 per cent of cures may be expected by laryngofissure.

Fig. 2. Advanced bilateral intrinsic cancer of the larynx. In this type of case, total laryngectomy offers a large per-

centage of cures provided there is not a marked glandular metastasis.

Fig. 3. Extrinsic cancer of the larynx. Total laryngectomy with dissection of the cervical glands, plus irradiation, have given most encouraging results in treating this type of laryngeal cancer.

Fig. 4. Extrinsic carcinoma of the larynx. Laryngectomy and excision of the upper portion of the esophagus, November 1921. Patient still living with no evidence of recurrence.

Fig. 5. Advanced intrinsic carcinoma of the larynx. Total laryngectomy February 1922. Patient aged 34 years. No evidence of recurrence to date.



Fig. 4



Fig. 5



Fig. 6. Advanced intrinsic carcinoma of the larynx. Total laryngectomy July 1925. Still free from recurrence. Has a splendid buccal voice. At right, photograph of larynx removed from patient.



Fig. 7. Physician, aged 76 years. Advanced intrinsic carcinoma of the larynx. Total laryngectomy February 1926. Still free from recurrence. Continues in the practice of medicine. At right, photograph of larynx removed.

MALIGNANT TUMORS OF THE EYE

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From the Widener Ophthalmological Institute of the Johns Hopkins University and Hospital

MALIGNANT tumors of the eye form a very small fraction of the clinical material of a practicing ophthalmologist. While we have all seen cases of successful extirpation of malignant tumors of various types in this domain, the statistics of the surgical results obtained by any single operator or institution would be most inadequate for the purposes of this symposium. In answering your chairman's request therefore I appealed to Major P. E. McNabb, the curator of the Army Medical Museum for data available in the Division of Ophthalmic Pathology which is conducted under his direction and under the joint auspices of the three national associations of ophthalmologists. I am deeply indebted to Major McNabb for the data which are presented in tabular form below (Table I).

In reviewing these figures certain facts of interest may be mentioned. The high percentage of cures among cases of carcinoma of the lids and conjunctiva is not surprising. The majority of these belong to the group of basal cell carcinomas of low malignancy but of great local destructive power. Occurring in or near the eye they usually come to operation at an early stage.

More significant are the 50 per cent cures found among the retinoblastomata. It is to be noted that, in this group, there was recovery in all those cases in which the eye was removed before extrabulbar extension had taken place. It is in relation to this group of cases that an improved awareness of the benefits of surgical treatment and of early diagnosis could be most useful.

Perhaps the most surprising aspect of these figures is to be found in relation to the malignant

melanomata, tumors generally regarded as the most malignant of all malignant growths. Even more significant is the fact that of the 18 of these cases in which enucleation was performed before extrabulbar extension had occurred 11, or 61 per cent, survived for 5 years or more. Here again we have evidence of the importance of early diagnosis and treatment. Not all these can be counted as permanent cures, for it is well known that late development of metastatic growths, 3, 10, even 20 years, after the removal of the primary growth may occur in these cases. Perhaps it may be not inappropriate to ask the distinguished group of surgeons here assembled what they consider may be the possible factors which hold the metastatic growths in abeyance during these long periods, or what may be the factors which release their growth again in malignant development. If we knew the answers to these questions, we might be a great deal nearer to the control of this terrible disease.

TABLE I

Tumor	Number of cases	Number with local recurrence	Dead from metastasis or other causes	Dead from other causes	Living and well 5 years
Carcinoma of lid and conjunctiva Per cent	2	20	20	20	3 60
Retinoblastoma Per cent		2 25	4 42	7	7 25
Malignant melanoma Per cent	23	3	26	3	6 18
					11 48

SUMMARY OF SIXTY FIVE "CURES" OF CANCER ABOUT THE MOUTH

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From the Department of Surgery Washington University School of Medicine

IN responding to the request for a summary of our 5 year cures of true carcinoma of the mouth and contiguous tissues we have tabulated all traced cases of true cancer (basal cell excluded) treated by us between 1915 and 1928 which are known to have been alive and apparently free of recurrence more than 4½ years after treatment of the primary growth. We have also attempted to convey some idea of the extent of the growths and with some hesitancy our interpretation of the cell differentiation.

Fifty five of the patients are from a series of cases reported previously and represent about 25 per cent of the total. In this series early growths were but 4.7 per cent, medium 16.6 per cent, advanced 55.5 per cent, 23.2 per cent were inoperable so that this 55 might be considered as 33.3 per cent of those originally presenting any possible chance of cure.

The relative discrepancy between the stage of advancement and the number of cures as shown in Column A of Table I is explained by the predominance of advanced cases in the series.

Over 65 per cent were classified as advanced or inoperable.

Column B Table I shows a more definite proportion between cell differentiation and cures and Column C shows a striking relation between cures and lack of demonstrable gland involvement. However there are enough cases with undifferentiated gland metastases that have gone 5 years without recurrence to show that even this extent of growth may not be a hopeless condition.

Table II indicates the type of treatment, which by preference, was gross destruction of the primary area, followed by radical neck dissection in every case in which that was practicable.

Since 1928 our proportion of supposed cures from radiation has very definitely increased.

TABLE II.—TREATMENT

Treatment	Cases
Radical operation primary growth	14
Radical operation primary growth and neck dissection	39
Radical operation primary growth and radiation	9
Radiation primary growth and neck dissection	3

TABLE I

A. Stage of primary growth			B. Microscopic grading				C. Glands Microscopic grading				
Early	Medium	Advanced	1	2	3	4	0	1	2	3	4
5	26	34	6	20	1	0		1	4	7	4

TABLE III.—NUMBER OF YEARS WELL

Alive and well, years	Cases	Alive and well, years	Cases
4½	4	10	2
5	10	12	5
6	2	13	3
7	9	15	4
8	6	16	2
9	15	17	3

FIVE YEAR CURES IN CANCER OF THE MOUTH, LIP, NOSE ETC.

FERRIS SMITH, M.D. F.A.C.S., GRAND RAPIDS, MICHIGAN

THE cases presented represent well developed or extensive lesions in most instances previously treated with escharotics or radiation.

2 The early superficial basal cell lesions treated with radium are omitted.

3. Seven cases, not included in this report, with squamous cell lesions, lived beyond 5 years but died later of secondary lesions.

4. Our experience leads us to believe that radium has only occasional value in squamous cell lesions and that coagulation in association with mass removal of the involved area, produces the best result.

5 The prime purpose of management is elimination of the lesion. Restoration of function and appearance demand proper consideration.

TABLE I—SUMMARY OF RESULTS

Name	Sex	Age	Location	Type	Glands	Local Invasions, metastases	Operation	Treated
T. U.	M	5	Lip, lower	Squamous Broder No. II No. 27226	+	+	5- 5-17 1-20-17	Excision. Neck dissection X-ray
C. M.	M	19	Lip, half upper	Squamous Broder No. II No. 26911	+	—	1- 4-16	Excision. Radiation
A. C.	M	25	Lip, half upper	Squamous Broder No. II		+	9-26-19	Excision. Radiation
J. H.	M	55	Cheek	Squamous Broder No. I No. 26611		+	8- 4-16	Excision. Radiation
N. M.	F	45	Astrum, above, cheek	Squamous Broder No. II No. 1622		+	9-26-15	Coagulation. Excision. Radiation
W. S.	M	64	Velum, cheek	Squamous Broder No. III No. 26917	+	+	6-25	Radium. Coagulation. Neck dissection neck
H. W.	M	50	Tongue, tongue	Squamous Broder No. I No. 1 091	+	+	2-26-15	Radium. Excision. Neck dissection
S. B.	F	50	Cheek, palate, chin	Squamous Broder No. I No. 27179	+	+	4-15- 7 4-27- 7	Neck dissection. Dissection. Coagulation of neck
R. E.	M	37	Mandible, cheek	Squamous Broder No. I No. 26767	+	+	10-26-26 1- 4-27	Excision. Radiation
H. B.	M	33	Inner canthus, nose	Basal cell		—	2- 9-16	Radium. Excision
E. E.	M	2	Nasal side	Basal cell			1- 3-15	Excision
K. P.	M	39	Nasal side	Squamous Broder No. III		—	8-15- 9	Excision. Caustic
W. C.	M	61	Eye, lower	Basal cell		—	1-11-17	Excision. Graft
H. G.	M	48	Face	Squamous Broder No. III No. 27426	+	+	2- 9-17 1- 3-17	Coagulation. Excision. Neck dissection
N. B.	M	29	Larynx, cord	Squamous Broder No. I No. 1661		+	Orig. Oct. '14. Secondary Apr. '15	Excision. Radium "push"



Fig. 1

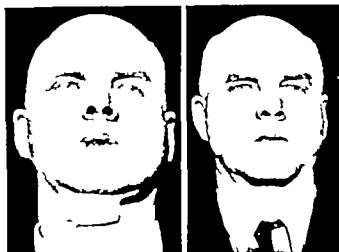


Fig. 2



Fig. 3



Fig. 4

Fig. 1 Squamous cell carcinoma of the upper lip. Excision of two-thirds of the upper lip. At right, appearance 6 years later

Fig. 2 Squamous cell carcinoma of the lower lip. Dissection of digastric and submental triangles. Excision of the entire lower lip. Result after reconstruction of the lip.

Fig. 3 Squamous cell carcinoma of the nose. Excision with cautery. Result after reconstruction.

Fig. 4 Squamous cell carcinoma. Coagulation. Excision. Block dissection of the neck. Skin graft repair.

Fig. 5 Squamous cell carcinoma of mandible and cheek. Excision of the jaw. Block dissection. Radiation.

CANCER OF THE SKIN

ERWIN P. ZEISLER AND Chicago

PRECANCEROUS LESIONS

IN this report an attempt will be made to present a statistical study of 500 unselected malignant new growths of the skin that were treated in private practice in the years 1914 to 1930 inclusive. Personal observation and a review of the literature lends support to the belief that cancer of the skin is not on the increase; that patients have become educated to apply for treatment earlier in the course of the disease and that more effective methods of prophylaxis and treatment are available. As long as the cause of cancer of the skin is not known, outside of the rôle of heredity and the congenital inherent tendency observed in that rare condition known as xeroderma pigmentosum it is important to recognize such factors as may produce long continued irritation as exciting causes. Among these are mechanical, chemical and actinic stimuli especially overexposure to wind and sunlight, occupational hazards in which arsenic, tar pitch, paraffin and radio-active substances act as carcinogenic factors, and finally the changes in the senile skin that predispose to malignancy. It is well known that an epithelioma seldom develops from a normal skin. The only effective preventive that we possess is a careful clinical, histological and morphological study of the so called precancerous dermatoses and their eradication. The more important precancerous lesions that demand attention are: (1) the senile keratosis which occur so frequently in elderly people on the exposed surfaces and which are known to develop into either basal or squamous types of epithelioma—seborrheic keratosis much less frequently undergo malignant degeneration; (2) leucoplakia with its associated etiological factors, tobacco and syphilis; (3) roentgen and radium keratosis and chronic radiodermatitis; (4) the scars of lupus vulgaris; and (5) certain nevi especially the black or blue-black pigmented moles and the hyperpigmented lentiginos of the aged from which may develop the most malignant type of cutaneous neoplasm the melanocarcinoma. Paget's disease and Bowen's disease were formerly considered to be precancerous but are now known to be cancers at their onset.

CLASSIFICATION OF EPITHELIOMATA

Prompt recognition of early lesions is as important in cancer of the skin as it is in cancer else-

where. A biopsy should be done if possible in all cases to determine the degree of malignancy and the probable radiosensitivity. The dangers of a biopsy have been overemphasized. By far the largest number of skin cancers about the face will be found to be of the basal cell type, also classified as non-epidermoid or rodent ulcers. The slow growth, low degree of malignancy, absence of metastases, and relative radiosensitivity gives a favorable prognosis in at least 90 to 95 per cent of these cases. Failures in our experience have occurred in less than 5 per cent and can be attributed to invasion of the deeper tissues such as periosteum, cartilage and bone to inadequate treatment or negligence on the part of the patient. Squamous cell, prickly cell or epidermoid cancers of the skin are much more dangerous, are characterized by rapid growth, early invasion of the deeper tissues, a tendency to early metastases and are more difficult to cure although Regaud has shown that the radiosensitivity is the same for both forms of skin cancer. Practically all cancers of the lip, buccal mucosa, floor of the mouth, tongue, and penis are of this type. In addition the carcinomata that develop on the site of a preceding radiodermatitis, in the scars of lupus vulgaris, and most of those of the extremities, belong in this group. An experienced dermatologist will as a rule have no difficulty in distinguishing a basal from a squamous lesion clinically but surprising variations in histological structure are often encountered when a biopsy is done. Another intermediate group the basal-squamous type has recently received careful study and it has been shown that lesions apparently of the basal type that metastasize belong in this group. Finally, there are a group of rare cases of multiple benign superficial epitheliomata, either basocellular or prickly cell or mixed, which can be differentiated histologically and clinically from Bowen's intra-epidermic carcinoma and the so called extramammary Paget's disease.

METHODS OF TREATMENT

Cancer of the skin on account of its accessibility and the readiness with which it can be recognized, lends itself peculiarly to successful treatment by surgery, chemical and electrical cauterization, and roentgen and radium therapy. In deciding on the best procedure to employ it is essential to consider the type of lesion, ex-

TABLE I—CLASSIFICATION OF 500 MALIGNANT NEW-GROWTHS OF THE SKIN

Basal cell epitheliomata	
Early superficial nodular or ulcerative	320
Advanced infiltrating deep seated types	36
Total basal cell epitheliomata	356
Squamous cell epitheliomata	
Early superficial	74
Infiltrating deep seated	25
Total squamous cell epitheliomata	102
Advanced epitheliomata not treated or receiving palliative treatment	13
Basal squamous cell epitheliomata	3
Malignant melanoma	7
Paget's disease	5
Bowen's disease (intra epidermal epithelioma)	2
Sarcoma, sarcomatosis	12
Total	500

pecially its depth extent mobility and the anatomical location. The duration the histology probable radiosensitivity and the effect of previous treatment are also of importance. The underlying principle of all forms of treatment is the destruction or radical removal of the cancer cell. Surgical excision will cure permanently many selected cases of epithelioma but in certain locations such as the nose or eyelids may be impractical. Equally favorable statistics can be presented by the advocates of modern roentgen and radium therapy. In our own practice we have employed at various times all the recognized methods of treatment and have not relied on any one single procedure. It is only natural that in a 20 year period considerable variation in prevailing modes of treatment should have occurred. In basal cell lesions we prefer to do whenever possible a preliminary thorough curettage under local anesthesia followed by cauterization of the base with acid nitrate of mercury (liquor hydrargyri nitratis) after the well known method of Sherwell. This is invariably supplemented by intensive roentgen or radium therapy although in recent years we have relied mainly on the latter. The cosmetic results are excellent and we have encountered no complications even in deep seated lesions about the eyes or ears. When cartilage or bone is involved either surgery, cautery removal or electrocoagulation is advised rather than radiotherapy. In squamous cell epitheliomata, particularly early lesions of the lips face or extremities our preference has been for a preliminary destruction with the electrocautery followed by radium therapy. Patients in whom the glands were involved at the time of examination were not

TABLE II—CLASSIFICATION OF FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA ALL TYPES ACCORDING TO LOCATION

Location	Cases
Nose	117
Cheek	106
Cantli and lids	65
Forehead	54
Lips	34
Tongue and mouth	21
Extremities	18
Ear	17
Neck	11
Trunk	9
Scalp	5
Chin	4
Total	461

TABLE III—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO AGE

Age in years	Cases
10 to 20	0
21 to 30	11
31 to 40	34
41 to 50	110
51 to 60	123
61 to 70	115
71 to 80	56
81 to 90	12
Total	461

treated and are not included in our series as it has been our principle to refer these patients for surgical treatment.

Whether prophylactic radiation or a surgical dissection of uninvolved glands is advisable as a preventive measure is a debatable question. It has also been our experience that all roentgen and lupus carcinomata should be treated surgically, or with the high frequency knife with subsequent plastic repair when necessary. Recurring cases of squamous carcinoma of the skin are treated with bipolar electrocoagulation or by interstitial platinum radium needles containing 1 or 2 milligrams of radium element inserted for 24 hours or longer. Suitable lesions of the tongue and buccal mucosa were formerly treated with gold radon seeds although we have records of several cases of cure with surgical diathermy without radium. At the present time we prefer the method of radium puncture used at the Curie institute enough 1 and 2 milligram needles being sutured in the tongue to give the necessary radiation dose in 7 days with due regard for the complications that may arise in the course of the treatment.

Radium therapy. The technique of radium therapy in skin epitheliomata will naturally vary

TABLE V.—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO SEX

	Cases	Per cent
Males	253	55
Females	206	45

TABLE V.—CLASSIFICATION OF EPITHELIOMATA ACCORDING TO NUMBER OF LESIONS

Single	413
Multiple	45
Total	458

TABLE VI.—METHODS OF TREATMENT EMPLOYED IN FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA ALL TYPES

Methods of treatment	Cases	Failures
Curettage with cauterization and fractional doses of X ray	85	3
Old technique prior to 1920		
Curettage with cauterization and massive doses of X ray	65	3
Curettage with cauterization and radium	38	2
Electrocautery with radium	84	0
Bipolar electrocoagulation		
Surgical diathermy	8	3
Serrero. Alone or with irradiation	0	4
Radium alone	30	1
Radium not initial	15	0
X ray alone	25	3
Total	41	16

with the amount of radium at the disposal of the operator. For the majority of superficial lesions following curettage and cauterization, we have found that surface contact applications with lightly screened full strength flat glazed applicators to be sufficiently accurate and effective. For more deep seated and extensive cases, radiation is used at a distance of 1 centimeter with molds or blocks of tubes screened with 0.5 millimeter gold and 1.0 millimeter rubber the dose being 50 to 60 milligram hours per tube figured on the basis of approximately 1 tube for each square centimeter. The entire dose may be given in a single treatment or over a period of four successive days after Regaud's method. In the tumor clinic of the Michael Reese hospital at the present time the Curie technique is being carried out with excellent results. Individual molds of Columbia paste are prepared for each patient and 5 or 10 milligram tubes are attached on the outer surface of the mold permitting uniform and accurate radiation. This technique is especially suitable for lesions around the eyes and for lip cases.

Röntgen therapy. The technique of roentgen therapy in our hands has also changed. Up to

TABLE VII.—CAUSES OF FAILURES IN 36 CASES TERMINATING FATALY

	Cases
Too advanced	13
Cartilage and bone involvement	8
Early metastases	3
Late recurrence (neglected to return for treatment)	3
Previous surgery and radiation (radio resistant)	5
Insufficient treatment	2
Apparently favorable cases	2

1920 we used the old method of fractional irradiation of Schiff and Freund, coils and gas tubes being used. Whereas this method was apparently fractional the actual result was to give an erythema dose within a short period, and therefore it was in effect an intensive treatment. Since 1920 we have used the standardized MacKee method of hyperintensive or massive dose radiation, 2 or 3 times the erythema dose being given in a single treatment or the dose being divided over several applications with a potential of 100,000 volts and no filter. The percentage of primary cures has not been markedly increased but there have been fewer recurrences and a decided saving of time. Roentgen therapy is of course also of great value as a postoperative treatment.

ANALYSIS OF CASES

Among the 500 malignant new-growths of the skin 356 were classified as basal cell epitheliomata, of which 320 were early superficial nodular or nodulo-ulcerative types and 36 were deep seated and infiltrating. Six cases were so far advanced when first seen that they were considered hopeless and were not treated or received only palliative treatment. Eight cases were classified as failures and eventually died of the disease and 30 recurrences were observed mostly during the first year all except 2 of which yielded to further treatment by cautery radiation or surgery. Three cases are known to have succumbed to late recurrences at an advanced age. Therefore, there were in these 356 cases 310 primary clinical cures (87 per cent) and 19 failures (6 per cent). If we include the recurring cases cured by further treatment the percentage of cures would be close to 94. However 58 cases did not remain under observation longer than 3 to 6 months and the percentage of 1 to 5 year cures therefore cannot be estimated as higher than 70 per cent. Many patients treated 15 or 20 years ago are known to have died of other causes and an attempt to follow up cases not heard from for years has been found to be unproductive of results. We have had great difficulty in having patients come in for observation at regular intervals for a 5 year period after

TABLE VIII—SARCOMATA AND MELANOMATA

	Cases	Clinical cures (1 to 5 years)	Failures
Melanocarcinoma	7	0	
Localized sarcoma	6	5	1
Sarcoma generalized metastatic	5	0	5
Kaposi's sarcoma	1	0	1

they have been clinically cured. Another important point to remember is the tendency in elderly patients to develop multiple successive epitheliomata in different locations. We have several patients followed for 5 to 20 years who belong in this group. For example an elderly woman of 61 was treated in 1913 for an extensive rodent ulcer of the temple which was cured and remained permanently well. During the next 20 years she was cured of at least a dozen basal lesions but eventually died at the age of 81 of a basal-squamous carcinoma of the cheek which recurred after treatment by surgical diathermy and radium and metastasized to the cervical glands. From the standpoint of a 5 year cure the lesion on the temple might have been considered a success but we have included these cases among the failures. Another woman of 77 was cured in 1914 of a large flat rodent ulcer of the forehead and a basal lesion of the inner canthus. Numerous epitheliomata were successfully treated in the next 14 years but she finally died at the age of 91 with a resistant squamous lesion of the cheek.

Of 102 squamous epitheliomata 74 were early superficial and 28 infiltrating and deep seated. Seven cases were so advanced that only palliative measures were advised. Twenty one involved the tongue and buccal mucosa with 14 failures. Of the remaining 81 cases including 34 lip cases there were 12 failures including recurring cases, of which 9 were fatal. The percentage of clinical cures was therefore about 71 and if we deduct 20 cases that were not followed the percentage of 1 to 5 year cures drops to 51. If we were to omit the intra-oral cases which had a mortality of 66 per cent the percentage of cures would be much higher. In this series of cases were 6 advanced cases of lupus carcinoma, 3 roentgen carcinomata, 3 carcinomata of the extremities that became metastatic and other cases which

TABLE IX—SUMMARY OF RESULTS OF TREATMENT IN FOUR HUNDRED AND SIXTY-ONE EPITHELIOMATA ALL TYPES

	Cases	Per cent
Basal cell epitheliomata	359	
Clinical cures, 1 to 5 years	252	70
Clinical cures not followed	58	16
Recurring cured by further treatment	30	8
Total clinical cures	340	94
Hopeless cases (No treatment or palliation)	6	
Failures (Late recurrences, fatal cases)	13	6
Total	359	
Squamous cell epitheliomata (including 21 tongue and intra-oral cases and 34 lip cases)	102	
Clinical cures, 1 to 5 years	49	48
Clinical cures not followed	20	20
Recurring cured by further treatment	3	3
Total clinical cures	72	71
Hopeless cases (no treatment or palliation)	7	
Failures (late recurrences, fatal cases)	23	29
Total	102	

had been ineffectually treated by surgery radiation pastes etc., and had become radioresistant.

We have had no cures in 7 cases of melanocarcinoma and have seen only disastrous results from surgery. It is our impression that these patients will live longer if they are left alone. The treatment of localized sarcomata by combined surgery and irradiation was successful in 5 cases.

CONCLUSIONS

In conclusion we feel that the treatment of cancer of the skin must be individualized, must be based on a thorough knowledge of the pre cancerous dermatoses and an expert appraisal of the clinical and histological features of each case. The therapeutic approach should aim to utilize all the known agents at our disposal including surgery, chemical and electrical cauterization radium and roentgen ray. In epitheliomata of the basal cell type the percentage of cures should reach close to 95 per cent. The prognosis in squamous lesions should be more guarded.

SYMPOSIUM TREATMENT OF FRACTURES

DEPRESSED FRACTURES OF THE SKULL

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TREPHINING for depressed fractures is an operation of antiquity but only recently has there been an experimental basis to indicate the effects arising from long continued bony depressions. Although trephining was done in ancient Egypt, and even in earlier times, the notes made by Hippocrates are among our first records of the surgery of depressed fractures. He counselled against operation and gave the sound advice that fractures with depression were not particularly dangerous unless the membranes were ruptured. The opposite view favoring operative treatment, prevailed during Roman times and the long period in which there was little or no advance in surgical knowledge. During the Arabian ascendancy and through the time of Roger of Salerno, the establishment of the European Universities, and the Renaissance the same ideas prevailed in Italy, France and England. The methods of dressing and the types of local application were considered to be of great importance.

In the sixteenth, seventeenth and eighteenth centuries, important writings are associated with the names of Ambrose Paré, Pettit, Percival Pott, John Hunter and Larry Abernethy. Hunter's successor sounded a note of caution to the radical surgeon, and the nineteenth century was filled with divergent opinions. It is surprising that, before the days of antiseptic surgery there was not a greater weight of opinion on the non-operative side. Following the period of Lister there was more general agreement upon the desirability of elevating depressions, and, in a general way this tendency has continued to the present.

It is a common conception that depressed fractures of the skull are responsible for a degree of generalized brain compression which is dangerous. Even more often it is said that untreated depressions cause progressive brain damage, leading to pachymeningitis adhesions, areas of cerebral softening and brain cysts. It is asserted frequently that depressed fractures should be elevated to prevent the later occurrence of con-

vulsive states, mental derangement and psychoses. When such conditions are associated with the presence of a depressed fracture, surgeons are prone to attribute them to the depression and to advise that it be relieved surgically. It seems timely to consider the results of this policy for surgeons of experience have become aware that operations in such conditions do not yield brilliant results and usually are fruitless.

It may be said at the outset that the governing principles in the management of any depressed fracture should be first, to prevent infection, and second to minimize the amount of brain scar and the number of sequelae resulting from scar and adhesions.

The factors which come into play when a depressed fracture is produced must be distinguished clearly. Depressed fractures of the skull, without dural laceration, may be associated with varying degrees of brain injury. These will be considered in one group. Depressed fractures of the skull with penetration of the membranes inevitably lead to brain damage, also of varying degrees. These will be discussed separately.

Let us first consider those depressions which have not penetrated the dura. It is customary to elevate such depressions when they are seen shortly after injury for patients with depressions of long standing also, this is the usual advice. If one has operated upon many persons with depressed fractures of long standing, and has opened the previously unpenetrated dura to inspect the condition of the underlying brain, he cannot fail to be impressed by the number of instances in which an apparently normal brain is uncovered, even though the depression has been present for years. Obviously this is not always true, and a yellow or degenerated cortex may be seen. The point of particular interest is that this is not invariable.

Questions immediately arise. Is a continued depression harmful? Does such a depression produce changes in the underlying brain by its mere presence, or is the brain change seen beneath certain of the depressed fractures caused by the

injury itself without reference to the continuance of the depression?

The desire to solve these two questions led us to undertake certain experimental work on animals some time ago. This work has been reported previously.¹ The experiments showed clearly that a depressed fracture, caused by striking a blow, produced both early and late pathological changes. Depressed fracture produced by pressure alone did not cause such changes. These depressions produced by the insertion of smooth foreign bodies into the skull caused no changes other than some condensation of the brain tissue beneath them nor was there any difference in the microscopic findings in the brains of animals sacrificed in 2 days after the depression had been introduced and those killed much later. If the foreign bodies were removed, later examination showed a rapid restoration of the contour of the brain and there was no evidence of a condensation of brain tissue at the location of the previous pit. Following the production of depressed areas by slow localized compression, neither pachymeningitis leptomeningitis, adhesions softening nor cysts were produced.

Our final conclusions were that, in cases of depressed non-penetrating fracture of the skull, the changes in the brain are caused by the force producing the injury rather than by the depression of the bone. Pathological changes in the brain appear to be more marked in the early and in the late stages than they do during the intermediate period, they are chiefly subcortical. Depressions of moderate size cause no pathological changes in the underlying meninges and brain.

If for the time being we consider only those depressed fractures in which there has been no dural injury, the question arises: Should such depressions be elevated? If this inquiry is examined in relation to the production of late changes in the brain, there seems to be very little reason for the operation. Likewise, there can be little sound basis for the argument that encroachment upon the intracranial chamber by reason of the depression, is sufficient to cause generalized signs of brain compression. If generalized brain compression is present, it results from other factors such as free hemorrhage. For the comparatively slight encroachment of a bone depression into the intracranial chamber, displacement of blood in the vessels and absorption of cerebrospinal fluid permit adequate compensation. Certainly there is no urgent reason for the elevation of a depres-

sion because of a conception that the depression itself is causing generalized intracranial pressure.

Another point may be raised. If a depression remains, may it be a source of mechanical irritation to the underlying brain by reason of the projection into the dura which it causes even though it does not produce degenerative changes in the brain? This is quite possible and we should hesitate to advise against the elevation of smooth depressions, even if we were sure that the dura had not been penetrated. However we feel safe in saying that in the presence of a depression without laceration of the dura, the immediate operations which are conducted so often, frequently with the patient in a precarious condition are not justified. In such instances one too often sees a patient brought into the hospital in a condition of shock, transferred from an ambulance to an examining table, changed again to a stretcher and transported to an X-ray laboratory where he is moved back and forth in the process of taking pictures then he is hurried to an operating room and an emergency operation is performed. Frequently little consideration is given to the advisability of using local anesthesia and the general condition of the patient is such that a hurriedly planned procedure is done. Less than the usual painstaking care is exercised, and less attention is given to details there is more hemorrhage at a time when the patient can ill afford to lose the blood than would have been the case with a more orderly preparation after the patient had recovered from shock.

The character of the treatment and the time it is instituted depend upon the condition of the patient and the presence or absence of an open wound. In a closed depressed, non-penetrating fracture, the time of operation is elective. Each case requires individual judgment. The only part of the treatment that is urgent is the prevention or control of infection. In some instances this involves relief of the depression. In others it may await a later attack. When the depression is elevated, the bone should be replaced so that no permanent defect will remain.

Determination of dural penetration usually is made by roentgen examination, but this is not so urgent that it needs to be done during the period of shock. One point in X-ray examinations is overlooked so frequently as to merit comment. It is customary to make the diagnosis from films showing anteroposterior and lateral views of the skull. All the details of a depression and its depth can not be judged from these. Views should be requested which show the exact area of depression in true profile. To obtain these, the rays between

¹Naffziger, Howard C., and Gleason, Mark A. An experimental study of the effects of depressed fractures of the skull. Surg., Gynec. & Obst., 1930, 11, 7-30.

the tube and the film should be exactly tangential to the area in question.

If we turn now to a consideration of the instances of depressed fracture with penetration of fragments through the dura and into the brain, a much more serious situation confronts us. A large proportion of these fractures are open, and the additional hazard of infection of the nervous system enters our calculation.

In the management of such injuries the presence or absence of an open wound and the length of time between the injury and the surgeon's repair bring in factors which can be judged wisely only by a competent surgeon at the time the patient is seen. Under ideal conditions, thorough surgical repair under local anesthesia with careful débridement of the scalp and other devitalized tissues, is desirable. In cases of open fracture such treatments cannot be deferred very long. In dealing with a closed fracture even if there is laceration and penetration of the dura by fragments, there is more latitude of action. Frequently when the general condition of the patient is poor postponement of such an operation for several hours or even for a day or two is a matter of good surgical judgment.

Wagstaff's follow-up of 280 patients with penetrating wounds of the dura showed that convulsive states followed in 28.7 per cent of them. In non-penetrating wounds, the incidence of fits was only 1.6 per cent.

In the light of our present knowledge of post traumatic convulsive states, our best opportunity of benefiting the patient lies in such careful repair that a minimal amount of scar tissue results.

In such surgical repair of penetrating injuries, a point that I wish to stress especially is the desirability of thorough removal of all devitalized brain tissue and of such additional tissue as has been contused sufficiently to indicate that its organization and repair will lead to a considerable cicatrix. After the removal of foreign bodies, the sucking out of devitalized brain and the tying of small cortical vessels in the region with resection of contused surfaces, will be repaid by lessening of the subsequent scar adhesions and contraction of the area, and consequent lessening of distortion

and deformity of the surrounding brain and ventricles which they cause.

Following the removal of loose penetrating fragments and of the devitalized area of brain, the importance of dural repair should be stressed. This is not always easy and extensive dural lacerations frequently demand that some new tissue be grafted in to fill the defect. Minor dural lacerations ordinarily can be closed with fine needles and silk. The larger lacerations may require the use of a bit of tissue from the temporal fascia or the pericranium to give a smooth covering. Failure to make such a complete dural closure may be justified at times, for instance when one is dealing with an open fracture, especially when the operation is performed some time after the injury, and there is evidence of infection. Such a set of circumstances is, however very unusual, and, in the earlier cases of both open and closed fractures, dural repair should be the rule. When such closure is not made complications are frequent. Occasionally protrusions of the brain through the opening will occur, a considerable extrusion beneath the scalp may ensue, and ultimately there is likely to be a fungus, with the attendant difficulties of long-continued dressings and delayed healing, or death may occur as a result of the rupture of a ventricle, an abscess, or meningitis. Such protrusion of brain through a dural defect is, of course particularly likely to occur when there has been widespread brain contusion and resulting edema.

Skull defects may be avoided by replacement of the bone following the repair of the brain and dural injuries. Such replacement is desirable whenever possible.

CONCLUSION

There is experimental and clinical evidence to indicate that a depressed fracture of the skull is not so harmful as has been considered generally. The trauma producing the depression causes the damage to the brain. Our efforts must be directed toward lessening the risk of infection, toward diminishing scar tissue formation in the brain, and toward avoiding skull defects as far as it is possible to do so.

THE EXACT RÔLE OF PHYSICAL THERAPY IN THE TREATMENT OF FRACTURES¹

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THERE is today in the minds of many the impression that the net result of the use of physical therapy in the treatment of fractures is to prolong the patient's convalescence. Whether or not this be universally true the fact is that it is true often enough to warrant serious consideration of the real value if any of physical therapy in this field and the proper rationale in its use if it is to be used.

In order to evaluate the exact rôle of physical therapy in the treatment of fractures it is essential that we first lay down the rationale which should govern all fracture treatment.

Our aim in fracture treatment is to restore a given individual to his normal habit of work or play as soon after his injury as possible and in as nearly normal an anatomical and physiological state as possible. Broadly this may be said to be our aim in the treatment of any human ill. But in the treatment of injury we face a problem with which we are not often forced to deal consciously in disease. That problem is the necessity of the patient's co-operation in the treatment if it is to be successful either in its final aims or in the time taken to accomplish them. In a case of pneumonia or of appendicitis the patient is a relatively passive agent and resumption of function in the affected organs depends largely upon automatic mechanisms independent of the patient's active efforts. In a fracture on the other hand though we may make the bone straight and hold it so until it has healed the only mechanism whereby the normal use and activity of the part may be rapidly regained whereby the strength and suppleness of the part may be restored is the active, voluntary use of the part by the patient. In any group of cases the question of whether or not we get rapid functional return in any given case depends all other factors being equal, almost entirely upon how early we get this active functional exercise on the part of the patient, and upon how generous he is with his efforts. To a larger extent than is commonly appreciated the functional end result is also dependent upon these same factors. It may be stated categorically that prolonged and slow functional recoveries are prone to be less complete than those that are relatively rapidly accomplished.

The ideal fracture treatment would be to wish the bone fragments into place, with the abolition of all pathology, and to hold them by force of will until the fracture was healed, while the patient went about his normal life without interruption. Translated into clinical terms this means reduction with as little attendant violence and damage as possible, early abolition of as much pathology as possible, as little interference on our part with function as possible during the bone healing process and as much functional activity as possible on the part of the patient. In any given case that method of treatment is best which can with safety most nearly fulfill these requirements.

It is obvious if we grant the validity of the preceding analysis that any given procedure can be of value only in so far as it aids in the accomplishment of one or more of these general aims of treatment. To assign to physical therapy any exact rôle in the treatment of fractures it is obviously necessary to be able to state what effects it can produce where those effects may be of value and how they may be best elicited; i.e. what methods of physical therapy are best employed.

First let us consider what effects physical therapy can be justly assumed to produce. I express a personal opinion, although I am certain that it is held by many others who have watched the development of the treatment of fractures when I say that much has been said and written of the mode of action of various physical therapeutic agents that is unfounded in fact and without other reason than unsupported theory or vivid imagination. I believe however, that we know that physical therapy can accomplish certain things, if properly and intelligently applied. It can relax muscle spasm it can relax vascular spasm. I feel that our certain knowledge stops there. There are obvious secondary results of these two actions which we must logically recognize. Relief of pain and soreness increased blood vascular and lymphatic circulatory efficiency, increased local metabolic activity are natural and undeniable consequences. I believe that these are the only effects which we are justified in depending upon in fracture treatment, with one excep-

tion which I shall mention later. How are these effects accomplished? There is again in so far as I can see no need to go far afield for abstruse explanations. There is no justification and indeed no need for talk about a little understood electrical force applied in the form of the static brush "pushing and forcing exudate out of the tissues", or of the part played by the electrical nature of diathermic heat in the production of its effects.

If one stops for a moment to consider the wonderful character of the human neuro-muscular and neuro-vascular reflex mechanisms, and of their activation by sensory impulses of a wide variety central as well as peripheral one can readily realize that the sensory effect of any given agent can well be responsible for resulting relaxation of both muscle and vascular spasm. And it is purely upon these two effects of physical therapy that we can depend for help in the treatment of fractures. The one exception to this statement lies in the use of muscle stimulation. There have been in use for many years various modifications of the electrical current for its effect in the production of muscle contractions. The earlier forms, in which both faradism and galvanism were used produced muscle spasm rather than a normal muscle contraction and constituted therefore a handicap rather than a benefit. There have been developed however through the use of rapidly interrupted galvanism associated with a surge variation apparatuses which can approximate the normal muscle wave of contraction and relaxation without spasm, although they can never equal the human mechanism in efficiency. One may consider this as a possible substitute imperfect to be sure for voluntary muscular activity by the patient in evaluating physical therapy in fracture treatment.

We may say that there are three elementary and basic forms of physical therapy available in fracture treatment: heat, massage, and muscle exercise. The first two are dependent for their effects on the relaxation of muscular and vascular spasm, and their action is wholly through the sensory arc of a reflex mechanism. It depends almost entirely on the pleasurable sensory effects produced. The third is of value largely for its pumping effect on the lymphatic and venous circulatory mechanism of the part as a whole, and in part for the artificial functional activity which results from its use. To these may be added the factor of moderate elevation as a circulatory aid. This elevation depends for its effect on gravity and it must not be of sufficient degree to interfere through this factor with the arterial inflow to the part. It should merely be sufficient to aid the lymphatic and venous drainage from the part.

The minute that one of these procedures causes pain or discomfort it ceases to be of value, and becomes a liability rather than an asset since it produces the very things we are trying to avoid—muscle spasm and vascular spasm. Heat is best applied therefore in an intensity low enough to produce merely the pleasurable effects of heat. Reddening of the skin is no criterion of the effect of heat. The patient's sensations are the only reliable criterion for intensity and length of treatment. Massage produces its effects through the pleasurable sensation it gives, and not through the force with which it is applied. Its results are due to relaxation of spasm and not to any mechanical milking or violent stimulation of the part. The gentler it is, the more regular it is the slower it is, the more uniform it is in force and direction the more pleasurable the feeling the more marked the relaxation of spasm. The stimulation of muscular contraction can be of no use if it is characterized by spasm. If it causes discomfort or actual pain or if it is carried on to the point of fatigue. Nor can it ever be of as much value as the patient's voluntary exercise of the same muscle.

There have been developed thousands of pieces of apparatus designed to cure the patient through the exercise of physical therapy. None of them is capable of doing more than evoking the mechanisms which I have cited. None of them is capable of accomplishing more in the way of relaxation of muscle and vascular spasm than is the use of heat and massage such as I have described, coupled with moderate elevation, competently and carefully carried out. Apparatus may spare the time and energy of the doctor may be made to replace lack of skill or practice on his part, may make it possible to take care of more people in a given time may exert some effect psychologically on the patient—good or bad—but it cannot accomplish anything which the doctor himself is incapable of accomplishing nor can it work through any other mechanism than that which I have described. A proper apparatus can offer a relatively inefficient substitute for the patient's voluntary muscular activity when it is either impossible or unsafe to secure voluntary active function. Any piece of apparatus, any so called modality is of value only in so far as it makes use of these principles. The whirlpool bath combines gentle massage and pleasurable heat. The static brush should provide the effects of pleasurable massage. Diathermy should provide the reflex effects of pleasurable heat. Intense diathermy producing all the heat the patient can stand, does harm. Intense heat of any other type does the

same thing Vigorous massage is damaging if it gives the patient anything but pleasure. Muscle stimulation if carried to the point of spasm discomfort pain or fatigue is damaging. But so is voluntary exercise of the patient if carried beyond pain limits and up to fatigue. The physiological basis of the use of all of them is identical.

Here then lies one reason why the use of physical therapy frequently results in the prolongation of convalescence—in the lack of appreciation of the physiological principles back of its use and the failure to appreciate the simplicity of the mechanism involved. The fixed idea that the *physical therapist* must do something instead of the viewpoint that his real job is merely to make it possible for the patient to do it himself.

Let us now take the specific phases of fracture treatment and with this conception of physical therapy see if and where it may be of value.

1 The reduction. The use of light stroking massage of the type described by Lucas Charnipionniere and Mennell or of any other agency which will produce the same results may be of definite value immediately following the injury and up to the time of reduction in helping to minimize the exudation into and infiltration of the tissues and in alleviating muscle spasm. It could well be combined with emergency traction to advantage in the period of inactivity between primary splinting and reduction if the facilities available make it possible.

2 The post reduction period. One of our objects in the treatment of a fracture is the early elimination of pathology before it can undergo organization into scar tissue. Immediately after a fracture there is hemorrhage and exudation and cellular infiltration in and about all the structures of the affected part. This pathology undergoes organization into tissue rapidly. Within 72 hours this organization is well started and by the end of 10 to 12 days it has progressed to considerable magnitude. In the first 5 to 10 days a large proportion of this exudation and infiltration can be removed from the part, before it can undergo organization, by any mechanism which will restore the normal circulatory efficiency of the part. It is here that physical therapy can be, I believe, of definite value in itself if the method used in the treatment of the bone lesion allows of its use. Light massage of the character already indicated heat of the type previously described or substitutes for them combined with moderate elevation can do much to aid in this early elimination of pathological processes. If it can be largely eliminated the amount of stiffness and soreness which will remain for later treatment and the amount of

late swelling on use and other circulatory handicaps due to scar tissue infiltration which will require attention will be greatly diminished and there will be less talk of the after treatment of fractures. To make it possible entails the use of methods of treatment for the bone lesion allowing of access to the part for physical therapy and the training of physical therapy technicians who know what we are trying to do and are capable in these early stages of giving the treatment with safety to the patient. I have met very few who are so trained. The maximum effect of such treatment is secured in the first few days. It loses its value progressively as the days pass by. Adequately and intelligently used I am convinced by practical experience that the convalescence time can be materially shortened. In addition I do not doubt but that the early restoration of adequate circulatory efficiency plays a large part in influencing the healing process in bone. Strangely enough it is in this phase of fracture treatment that physical therapy is rarely used and the development of its use by the physical therapists has been very much neglected. And yet it is only in this phase that it can play an essential part in treatment.

If the method of treatment or the nature of the injury allows of full function during this stage there is no use or need for muscle stimulation unless it be used as a substitute for active muscle exercise in a patient who will not give his voluntary help. If the method of treatment used is such that active motion cannot be used or is definitely limited muscle stimulation of the proper type can help greatly as a partial substitute. I should like to stress the point that the muscle activity desired in this instance is not the subminimal invisible contraction desired in the treatment of paralytic muscle, but is the maximal contraction obtainable without spasm or discomfort, and stopped short of fatigue. It is a substitute for the patient's active use of the part. Even in the presence of circular plaster or splints its use can be managed through the windows or apertures in the apparatus.

3 After treatment. After the bone has healed and the patient is in position to regain progressively the full use of the part is the stage in which physical therapy is almost universally used—and abused. There are certain definite facts which must be stressed before discussing the use of physical therapy at this time. No physical therapy that I am familiar with can restore strength and suppleness to a limb, regardless of who gives it, or what complicated and impressive machinery is used to carry it out. The only factor

essential in the regaining of functional activity by a patient is the voluntary active use of the part progressively by the patient. These facts are incontrovertible. The doctor who sees the case, the technician who administers treatment, and the patient who receives it must all know this fact.

Physical therapy may be used to make it easier for the patient to do his part by temporarily ridding the part of soreness and stiffness through the mechanism already described so that it is easier for him to use the part. It may be used to get rid of the unpleasant effects of overexercise—pain, soreness, stiffness, and swelling. But it cannot successfully be used to restore *per se* strength and suppleness to a part. The only way to strengthen wasted muscles permanently or to limber up stiff joints permanently is for the patient actively to exercise them. Physical therapy can do no more than make the voluntary function easier and less distressing. Here lies the second reason why physical therapy so often hinders the convalescence of the patient. He does not know that the heating, the rubbing, the various complicated appliances used cannot possibly make him well and for week after week and month after month he sits patiently waiting for this easy and effortless recovery to take place. I know that many of the physical therapists who treat thus

hopeful but deluded patient are firmly convinced that they can get him well. And I have reason to believe that many of the doctors of these patients have never given a thought to what either the patient or the physical therapist know or believe. And physical therapy under such auspices becomes an idle and futile gesture, but unfortunately one in which the patient is taught to have infinite confidence.

There are here presented the grounds which exist for the belief that physical therapy can be of value in fracture treatment. The attempt has been made to show the basically simple *modus operandi* upon which all physical therapy is dependent for its effects, regardless of the complicated trappings in which it may be dressed. The attempt has been made to indicate when and how these effects may be of value. Attention has been called to defects in the present application of physical therapy to treatment of fractures which are widespread and which serve in many instances to delay convalescence rather than to hasten it. The solution lies in education—first of ourselves, next of our technical assistants, and lastly of our patients—to the realization that in treatment of fractures the thing that counts, apart from the actual reduction, is not what we can do for the patient, but what we can help the patient to do for himself.

THE SIMPLIFICATION OF THE TREATMENT OF FRACTURES

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THE simple methods which are applicable to the reduction and fixation of most fractures seem to have been pushed into the background during the last few years by the vast amount of literature advancing pet methods in operative treatment. It is true that a certain number of fractures should be recognized immediately as operative cases, but the decision as to whether or not a given fracture is operative should be made at once, and not delayed until a bad result has occurred. There are certain fundamental principles which should be kept in mind. Immediately a fracture comes to hand the structures of the anatomy involved should be visualized. Before the fracture is thought of as a pathological entity, the first step should be the mental picture of the attachments of muscles and the estimation of their strength, the angle at which they pull, and the amount of displacing effect they have on the fracture as it exists. The second step should be a thorough consideration of the equipment necessary for reduction of the fracture and the equipment necessary to hold it in reduction. This is fully as essential as having all operative equipment at hand and ready for immediate use before attempting any open operation.

The theory of reduction and proper retention of fractures is based on one principle—traction balanced by countertraction. The fragments must be held in alignment by counterbalancing the displacing effect of the muscles attached to them. In most cases this is simple. Open operation is unnecessary in the vast majority of fractures in my opinion. If the anatomy is understood, the physiology of the structures is taken into consideration and the details of the mechanics of reduction and retention are carefully thought out.

Many times traction for maintaining reduction is carelessly applied. Usually the best method of maintaining traction is by the application of adhesive plaster to the skin. It should not be applied as longitudinal bands but as three-tailed strips (Fig. 1) the wide center bands run directly up each side of the limb and the narrow side strips are wound corkscrew fashion around the limb (the anterior strips being crossed and wrapped around from front to back and the posterior strips from back to front). This eliminates straight downward pull on the skin, grips the limb circu-

larly, does away with much skin irritation and allows greater weight to be applied with less discomfort. Almost any fracture can be pulled into line if skin traction is applied in this way with due consideration for the parts involved.

The manual reduction of fractures is ill advised as a general rule because the strength of the muscles attached around the fracture is greater than the force which the operator can apply by manual manipulation. The operator's muscles tire and pass from tonic contraction into clonic contraction. Jerky motion will irritate the tissues about the fracture and cause reflex spasm in the muscles which further interferes with proper reduction. Any effort at reduction should be steady, strong and prolonged to the point where the patient's muscles are tired out and relaxed sufficiently to permit the fragments to be brought into alignment and this can be accomplished only by mechanical means which relieves the surgeon of strain and frees his hands to manipulate the fragments until the ends can be approximated and forced into contact. Therefore in every fracture provision should be made for applying slow, steady and prolonged traction.

In fracture of the arm when the line of fracture is transverse or nearly so, immediate reduction may be made by means of a heavy muslin bandage looped around the patient's wrist or elbow and passed over the surgeon's shoulder (Fig. 2). The patient is secured to the table by a bandage placed around the chest under the axilla, thus fixing him firmly on the table and permitting the kind of traction necessary. Traction always calls for countertraction and this countertraction should be arranged for before traction is started. With the bandage loop around his shoulder the surgeon may press his foot against the cross bar between the legs of the table and use his weight against the bandage to apply traction. He is under no strain, both hands are free, there is no interference with his sense of touch, and the pull can be continued until the patient's muscles are thoroughly relaxed when the reduction can be accomplished with ease.

Strong traction may be applied in fracture of the leg by a Collins hitch (Fig. 3) placed around the ankle and a double pulley fastened under the sole of the foot by tying the ends of the hitch through the eye of the pulley. Another double pulley is attached to the foot of the table, and the



Fig. 1

two are joined by a piece of clothesline. Here too countertraction must be provided, the simplest method being to pass a sheet between the patient's thighs and tie it to the head of the table. Tremendous traction may thus be applied without any marked exertion on the part of the surgeon, who is free to manipulate the fragments while an assistant increases the traction as directed.

All is not finished however when the fracture is reduced. The application of a cast or splint while maintaining the fracture in position is no mean feat and must be carefully planned before reduction is started. Many fractures have been displaced after proper reduction because of improper handling by an assistant while the surgeon was engaged in applying the apparatus. No man can hold a weight in his hands for 15 minutes, or 10 minutes or even 5 minutes in exactly the same position, and the danger of inadvertent movement is increased by the number of hands supporting the injured member. Fractures must be reduced mechanically and must be maintained mechani-

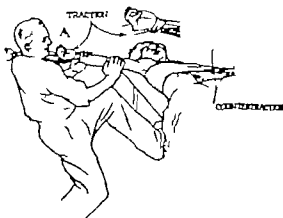


Fig. 2

cally and the mechanics of applying the retention apparatus must be arranged beforehand, or the case may come to grief. It is a difficult matter to apply a cast or splint without an assistant, and in many cases the assistant at hand is not skilful, is frequently nervous, and cannot be depended upon to do exactly the right thing at the right time.

In a fracture of either the leg or arm it is sometimes necessary to maintain traction while the



Fig. 3

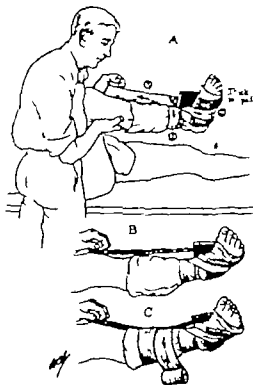


Fig. 4

Buttock over edge of table

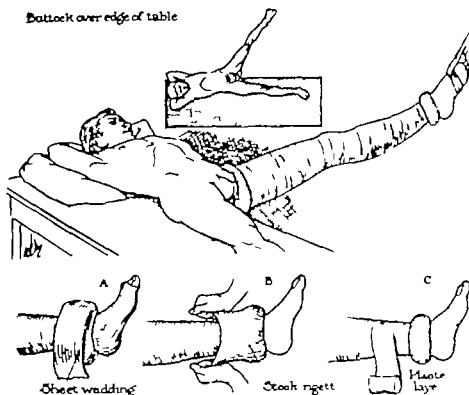


Fig 5



Fig 6.

cast is being applied. If the limb is in a horizontal position, steady support should be given above and below the fracture as well as at the point of fracture in order to prevent angulation. For the leg a wide muslin sling supported from a horizontal bar above can be applied in such manner as to eliminate the possibility of angulation after the fracture is reduced, and permit maintenance of traction in any given line and in any given amount. This sling is made with a piece of muslin equal in width to the length of the member to be supported. It is torn in 4 inch strips from each end to within 4 to 6 inches of the middle leaving the center section intact, thus forming a sling the narrow strips of which tied to a horizontal bar above the limb can be adjusted at any desired point to form a smooth and firm support over the entire length. Traction can be continued by a Collins hitch below and above by the use of either pulleys or weights. The cast is applied over this muslin support the bandage being passed between the strips and made continuous over the entire posterior surface of the leg. When the plaster is firm enough to preclude the possibility of bending, each alternate strip may be cut loose from its overhead support and the application of plaster continued. When the cast is completely hardened the remaining strips may be cut from the overhead support and the windows in the cast

which remain as a result of surrounding the strips with plaster can be covered.

In the application of plaster where the limb can be fixed perpendicularly as in the forearm traction can be made by passing loops around the fingers and attaching these loops to an overhead support. If the weight of the arm does not afford sufficient countertraction a sandbag thrown over the lower end of the humerus just above the elbow will give all the countertraction necessary to maintain the fragments in position.

In maintaining inversion in fractures above the ankle particularly in Pott's fracture and fracture of the os calcis it is frequently difficult to rotate the foot inward and maintain this inversion without denting the cast at some point as inversion must be maintained by pressure of the assistant's or the operator's hands. Here it is advantageous to protect the foot with a heavy felt pad with a few turns of plaster bandage around the ankle bringing the plaster down from the ankle over the outside of the foot, under the sole and up toward the knee on the inner side. An assistant grips the bandage roll in one hand, and while supporting the leg with the other hand maintains the knee in right angle flexion supported against his chest (Fig 4). If the bandage is passed around the foot immediately under the astragalus the foot will be inverted at the subastragaloid joint, the location

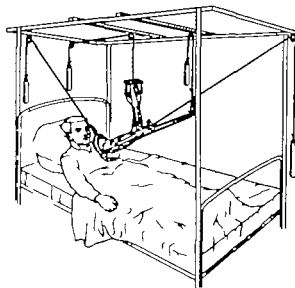


Fig. 7

where inversion should take place. Inversion is easily maintained and the operator's hands are free to apply the cast. Grasping the ball of the foot to turn the toes in merely inverts the anterior part of the foot, but does not invert the subastragular bones.

Casts applied for fractures or injuries in or near the knee joint frequently do not accomplish their purpose—namely immobilization—because the cast is not applied so that it will give equal leverage on both sides of the fracture. The extension of the cast down onto the leg toward the foot can be carried out simply and easily but the application of a long cast to the thigh is not so simple. The muscles around the thigh are heavy and immobilization is impossible unless the cast is made very snug, and if the cast does not extend as far above the fracture as below the immobilizing effect is not good. Therefore where it is desired to immobilize the knee or to support the femur after a fracture of this bone has healed, the patient should be drawn well over to the side of the table and the leg should be brought into full abduction (Fig. 5). The top of the cast may then be brought up into the gluteal fold and up against the ischium thus giving as long a lever above the knee as below. If the upper and lower ends of the cast are well padded with sheet wadding and the stockinet is rolled back over the sheet wadding after the cast is applied, there is ample protection of the soft parts from pressure (Fig. 6). A walking caliper can be made by placing a U shaped piece of iron under the foot, the uprights of the iron being included in the lower end of the

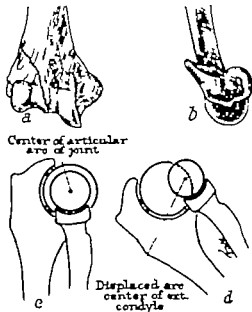


Fig. 8

cast on each side of the leg. The ischium will rest on the pad at the upper end of the cast and the weight will be transmitted to the iron.

In fracture of the surgical neck of the humerus when it is necessary to maintain traction to reduce the fracture, the apparatus used should center in its motion exactly under the glenoid fossa. Traction should be started with the arm in about 30 to 35 degrees of abduction and the elbow gradually be brought forward as the arm is abducted. If the arm is immediately abducted and put in traction, the upper end of the lower fragment is thrown downward and forward as the elbow is brought outward, because here the attachment of the pectoralis major acts as a fulcrum, and until this muscle is either relaxed or stretched the lower fragment cannot be brought down into position (Fig. 7).

Fractures of the lower end of the humerus into the elbow joint probably give as unsatisfactory results as any class of fractures. This is due to several factors. In the first place, the bones of the forearm articulate with two almost completely separate joints on the end of the humerus, and when fracture into the elbow joint occurs these joints are separated. The muscles attached to the lower end of the humerus have a tendency to displace the fragments in different directions. The centers of the two condyles around which the radius and ulna rotate on the lower end of the humerus normally are exactly in the same axis, but when the condyles are fractured the alignment

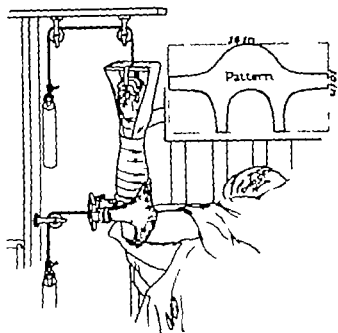


Fig. 9. (See Fig. 10)

of this axis is disarranged and is very difficult to re-establish because the humerus just above the condyles is extremely thin in its anteroposterior diameter while its lateral diameter is widened (Fig. 8). Open reduction of such fractures is not satisfactory as a rule because it entails considerable damage to the ligamentous attachments around the elbow. Furthermore, it is very difficult to fix the two condyles to the lower end of the humerus on exactly the same pivot, because the lower end of the upper fragment, which articulates with these two condyles is so thin from front to back that it is next to impossible to drive a peg or nail from below upward and have any stability between the fragments. If they are wired the wire does not hold them in firm enough position to maintain the true axis, and as they heal there is apparently a great tendency for excess callus to form which further contributes to blocking of the joint. These fractures can be reduced and maintained in reduction much more satisfactorily by traction applied in a very simple way.

The treatment is based on the fact that the ligaments attached to the condyles of the humerus and the radius and ulna will pull the fragments back into their normal centers and alignment, if the muscles attached to the condyles are balanced and relaxed. Therefore the forearm is suspended at right angles to the humerus with just enough traction applied to hold the elbow clear of the bed, thereby permitting the pronators and supinators of the forearm to find the position in

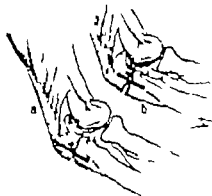


Fig. 10

rotation in which they balance each other. Beneath the muscle attachments are the ligaments and the capsule attached to the fragments. If traction is applied to the forearm with the elbow flexed the lateral ligaments and the posterior ligaments are pulled tight. If continuous traction is made over the upper end of the forearm near the elbow with the elbow flexed the anterior capsule is stretched tight as well as the lateral and posterior ligaments and thus pulls all the fragments of the lower end of the humerus into fairly normal relation with the radius and ulna, and re-establishes the relation of the axis of both condyles.

The procedure is simple and is easily carried out by cutting felt in a pattern which will fit closely around the elbow on its flexor surface. With traction applied to the felt close to the elbow joint, immediate traction can be transmitted to the fragments through the ligaments and muscles of the forearm at the elbow (Figs. 9 and 16).

Fractures of the olecranon always require open operation if the fragments are separated and the ligaments torn which is usually the case. These fractures can be fixed in such a way that immobilization is unnecessary. The usual custom is to drill through the upper end of the lower fragment and through the middle of the upper fragment passing kangaroo tendon, silk or wire through the two holes to fasten the fragments together. Can cancellous bone does not stand as much pull without atrophy as do the heavy attachments of the muscles. The triceps tendon is attached to the olecranon, and if malleable iron wire is used (which is the strongest form of wire with which we are familiar), the wire can be passed through the triceps tendon posterior to the long axis of the olecranon and ulna, and fastened to the lower fragment which is composed of hard cortical bone (Fig. 10). If the fragments are held together in

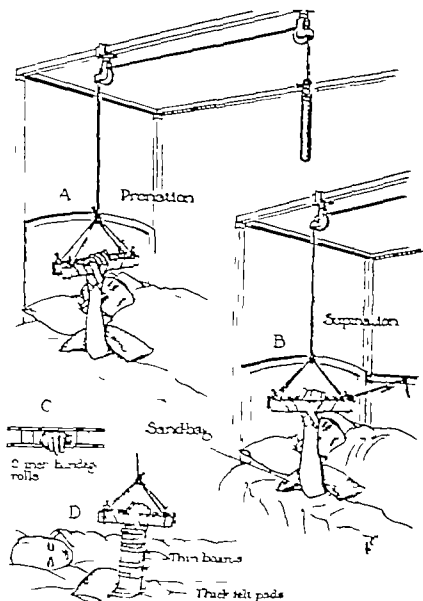


Fig. 11

this way the pull of the triceps muscle is transmitted through the wire directly to the lower fragment, and any angulation at the posterior end of the fracture line is prevented. If the wire is put in line with the axis or anterior to the line of the axis, the triceps tendon has a tendency to separate the fragments at their posterior junction, and if they heal in this position extension is limited because the olecranon is pulled upward and into the olecranon fossa.

Motion can be started within 24 hours after

operation in these cases, and union should be complete in from 4 to 6 weeks without disability in the elbow.

Fractures of the forearm, which are probably more difficult to reduce than any other fractures in the body in many instances should not be treated as ambulatory cases. When there is serious displacement, reduction by manual manipulation is usually impossible. The fascia surrounding the muscles of the forearm is strong; the muscles are extremely active and tend to con-

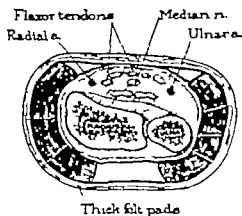


Fig. 12.

tract and maintain the fragments in malposition. There are no fractures which need steady continuous tiring traction more than do fractures of the forearm. Serious disability results if union is permitted with angulation or abnormal rotation between the radius and ulna. Disability of the forearm means disability of the hand, because the dexterity of the hand is dependent to a great extent upon the integrity of the bones of the forearm.

In order to maintain traction on the forearm it is necessary to apply some form of countertraction inasmuch as the weight of the upper arm is not sufficient to overcome the pull of the muscles. Therefore the forearm should be placed in suspension. An adhesive plaster cuff is placed around the wrist, attached to horizontal strips of wood at the level of the metacarpophalangeal junction. Countertraction may be applied by placing a sandbag of the requisite weight across the lower end of the humerus just above the elbow. Rotation of the radius may be controlled by attaching to the horizontal crossbars a rope which controls this motion. When sufficient traction has been attained to bring the fragments into alignment they may be supported by double board splints on the flexor and extensor surfaces (Fig. 11).

In fracture of the radius without fracture of the ulna, there is in addition to the deformity a disarrangement of the radio-ulnar joint at the wrist. As the radius shortens, the relation of the radius and ulna at the wrist joint is changed, the hand is pulled into radial flexion, and the ligaments which support the radio-ulnar joint are either torn or stretched. In every fracture of the radius without fracture of the ulna normal length of the radius with normal relation of the fragments so far as rotation is concerned must be re-established in order to re-establish complete function in the hand and wrist. Even with restoration of normal length in the radius, there is

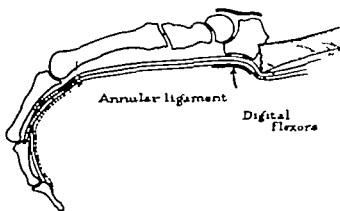


Fig. 13

sometimes severe injury to the ligaments holding the two bones together which will result in serious disability if not given special support. Relaxation of this joint may occur which will leave a serious disability so far as the strength and the dexterity of the hand are concerned. After such injury, therefore, whether it be fracture in the shaft of the radius or Colles fracture this joint must be supported and this can best be done by placing a thick felt pad laterally over the radius and over the ulna allowing each of them to fold around the flexor and extensor surfaces. The two pads are then forced toward each other by including them in a tightly strapped circular band of adhesive plaster. It is impossible to put a circular band snugly around the wrist unless the flexor and extensor surfaces are protected from pressure because it would interfere with circulation and cause swelling and congestion in the hand but with thick pads applied laterally this is prevented, as the adhesive plaster does not touch the flexor and extensor surfaces (Fig. 12).

Probably the most common fracture with which we have to deal is Colles. In this fracture there is a backward and upward displacement of the lower fragment, and the fragments are usually rather firmly impacted. When the lower fragment moves backward and upward it carries backward with it the annular ligament. The lower articular surface of the radius is carried backward and upward, and, in a typical deformity, instead of the lower end of the radius facing toward the flexor surface, it faces toward the extensor surface. This deformity also produces a double bend in the flexor tendons, forcing them under the lower end of the upper fragment where they are kinked rather sharply backward to pass toward the fingers under the annular ligament, which has been carried backward. This double bend, in tendons which should run straight from the muscles from which they originate to the bones to which they



Fig. 14

are attached diminishes the strength of the pull of the muscles (Fig. 13). In addition the hand is carried into radial flexion by the shortening of the radius, and the radio-ulnar joint is disarranged. Unless this deformity is corrected unless the lower fragment is brought into correct apposition with the upper fragment, the double bend in the tendons removed and the lower articular surface of the radius brought into proper angle with the long axis of the radius (namely facing slightly toward the flexor surface) three serious disabilities occur. First limitation of supination because of the disarrangement of the radio-ulnar joint; second limitation of flexion of the wrist, because of the change in the angle at which the lower fragment articulates with the upper; and third, diminution in the strength of the hand because of the displacement of the lower fragment plus the double bend in the flexor tendons at the wrist and possible adhesions.

Reduction is easily carried out, and the earlier the better. Traction should be applied over the base of the hand by a bandage loop extending from the hand over the operator's shoulder. First the impaction should be broken up. With the thumbs over the ends of the fragments on the extensor surface of the lower end of the radius, the deformity should be increased until the fracture is perfectly loose and the fragments move freely on each other (Fig. 14). Until complete breaking up of the impaction is brought about traction is useless, but when it is accomplished longitudinal



Fig. 15

traction on the arm will bring the lower fragment down to a point where its fractured surface is at a level with the fractured surface of the upper fragment. Pressure forward with the thumbs on the lower fragment, and backward with the fingers on the lower end of the upper fragment, will then force the fragments into alignment and bring the articular surface into its normal position (Fig. 15).

In elderly patients it is sometimes impossible to re-establish the normal length of the radius, because in the impaction there has been an actual disintegration of cancellous bone cells, resulting in a loss of bone substance which permanently shortens the radius. In these cases some deformity will remain.

No one method can be made to apply to all cases, even those of the same type. Variations must be made according to the needs of the case. When dealing with fractures one is dealing with a problem in mechanics. A fundamental knowledge of the anatomy and physiology is as important in dealing with the stress and strain on the fractured fragments as is the knowledge of physics to an engineer in undertaking a problem of purely mechanical construction. The main difference is that the surgeon must take into consideration the fact that power and breaking force are applied to a fracture during 24 hours of the day, because the muscles continue to contract until they encounter resistance which will counterbalance the strength of their pull. The surgeon also has the additional problem of not being able to exert enough mechanical force directly on the part to be treated to bring it into alignment and maintain it in alignment without the hazard of injuring living tissue.



Fig. 16 Anterior and lateral views of comminuted fracture of lower end of the humerus into the elbow joint. The same 24 hours later after the application of extension.

Therefore ingenuity and ability to meet individual requirements are much more important in dealing with a fracture than in the average engineering problem.

In the methods given herewith only such mechanical apparatus has been described as can be improvised from materials to be found around almost any farmhouse. These methods are not advocated as the only means of handling such problems but are advanced to point out the fun-

damental principles of treatment of certain fractures and they can be varied by the ingenuity of the surgeon to meet the requirements of any given case. As stated in the beginning of this article there are certain fractures which cannot be reduced and maintained in reduction satisfactorily without open operation but the differentiation should be made early in the case and not be postponed until faulty union or nonunion has resulted.

THE RUSSELL EXTENSION METHOD IN THE TREATMENT OF FRACTURES OF THE FEMUR

A REVIEW OF THE ANATOMICAL RESULTS OBTAINED IN A GROUP OF FIFTY-ONE CASES

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In 1923 R. Hamilton Russell of Melbourne Australia, first published his report of a method to obtain reduction of the fragments in fractures of the femur. "This employs a natural and comfortable position of the extremity in which but a relatively small amount of traction is required to restore the balance or equilibrium of the muscles of the thigh when it is applied distally to the knee joint."

In 1927 Ryan of Philadelphia called attention to this method, reporting 8 cases. In 1929, Ridgely and Bongardt 15 cases. In 1930, Jopson and Brown 43 cases and in 1931 Lund published his end-results in 22 cases.

At the Philadelphia meeting of the Clinical Congress of the American College of Surgeons in 1931 Summey demonstrated the end-results of a group of 58 cases of fractures of the femur treated by Russell's extension in which there was but one case of non union caused by the interposition of muscle and requiring open reduction. This work has never been published.

Following this report of Summey we decided to use this method in the surgical services of the Graduate Hospital of the University of Pennsylvania, the Pennsylvania, Bryn Mawr German town and Burlington County Hospitals.

The impression made on Scudder by our first report, together with his knowledge that we were using this type of extension almost routinely in our five hospitals, may be responsible for his invitation again to review our results.

The fact that 10 years after the publication of Russell's article we have been able to find in the literature records of but 87 cases treated by this method containing the data required for a critical analysis has been a surprise.

These reports are uniformly favorable and Lund expresses the opinion of the others in saying "I have been impressed with the ease of application of this method and by the comfort it affords the patient. It facilitates the dressing of compound wounds and makes easy daily inspection and measurement. Early massage and other physical therapeutic measures may be given together with excellent care of the soft structures and adjacent joints. The end results have been excellent, and a minimum of residual disabilities of the joints have occurred compared to those following other methods." In but one of these reports is there any warning of its limitations and this is found in the original article of Russell. The apparatus is far from fool-proof and cannot and will not look after itself."

Two definite impressions developed very early in this study and became more fixed as the work progressed: (1) That the results obtained in these five hospitals were far from uniform. In fact, they varied so much that it was a matter of general comment. (2) That the average of the anatomical results was not as satisfactory as we had believed it to be.

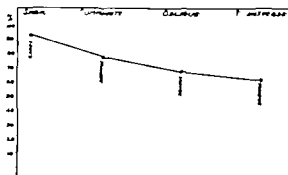


Fig. 1. Effect of the type of fracture on anatomical reduction.

Fig. 1A. No. 1 Robson, age 5 Burlington County Hospital. Spiral comminuted fracture upper third of femur. Picture taken before application of extension.

Fig. 1B. No. 2 Robson, Burlington County Hospital. Age 5. Picture taken at time of discharge from hospital. Alignment 50 per cent, overlapping 25 per cent, end-to-end apposition 12.5 per cent, total 87.5 per cent.

Fig. 1C. No. 3 K. Johnson Bryn Mawr Hospital. Comminuted intertrochanteric fracture. Picture taken before reduction.

Fig. 1D. No. 4 K. Johnson, Bryn Mawr Hospital. Comminuted intertrochanteric fracture. Picture taken at time of discharge. Alignment 50 per cent, overlapping 5 per cent, end-to-end apposition 2.5 per cent, total 57.5 per cent.

Fig. 1E. No. 5 J. Johnson, 33 years of age, Graduate Hospital. Oblique fracture middle third of femur. Picture taken before reduction.

Fig. 1F. No. 6 J. Johnson, 33 years of age, Graduate Hospital. Picture taken at time of discharge from hospital. Alignment 50 per cent, overlapping 25 per cent, end-to-end apposition 17.5 per cent, total 92.5 per cent.

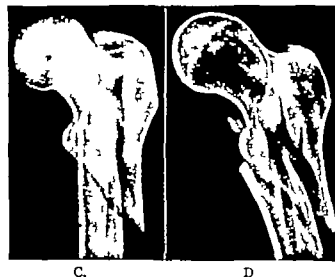
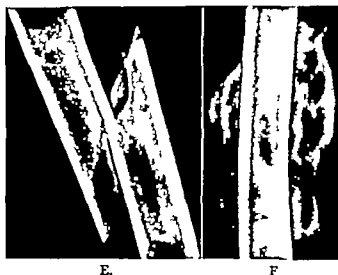


Fig. 1G No. 1 Mignon, Burlington County Hospital, age 76 years. Oblique fracture middle third of femur. Picture taken before application of extension.

Fig. 1H. No. 2 Mignon, Burlington County Hospital, age 76 years. Picture taken at time of discharge. Allignment 45 per cent, overlapping minus 25 per cent, end to end apposition 5 per cent, total 30 per cent.

Fig. 1I. No. 1 Howard, Burlington County Hospital age 12 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. 1J. No. 2 Howard, Burlington County Hospital, age 12 years. Picture taken at time of discharge from hospital. Allignment 50 per cent, overlapping 25 per cent, end-to-end apposition 15 per cent, total 90 per cent.



Fig. K. No. 1. Minton, Pennsylvania Hospital, 63 years of age. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. L. No. 2. Minton, Pennsylvania Hospital, 63 years of age. Picture showing reduction following the application of Russell extension.

Fig. M. No. 3. Minton, Pennsylvania Hospital, 63 years of age. Picture taken at time of discharge from hospital, showing failure to maintain the reduction which was at first obtained. Alinement 50 per cent, overlapping 5 per cent, end-to-end apposition 25 per cent, total 60 per cent.



Fig. N. No. 1. Campbell, Burlington County Hospital, 45 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig. O. No. 2. Campbell, Burlington County Hospital, age 45 years. Picture taken after application of extension, showing partial reduction.

Fig. P. No. 3. Campbell, Burlington County Hospital, age 45 years. Picture taken at time of discharge from hospital, showing failure to maintain reduction which was obtained following the application of extension. Alinement 42 per cent, overlapping 25 per cent, end-to-end apposition 10 per cent, total 77 per cent.

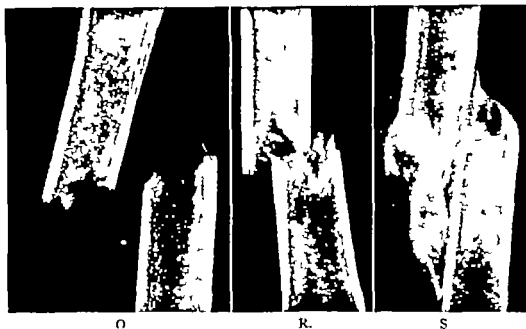


Fig 1O No 1 Festas, Pennsylvania Hospital, age 10 years. Transverse fracture middle third of femur. Picture taken before application of extension.

Fig 1R No 2 Festas, Pennsylvania Hospital, age 10 years. Picture taken after application of extension showing partial reduction.

Fig 1S No 3 Festas, Pennsylvania Hospital, age 10 years. Picture taken at time of discharge from hospital, showing failure to maintain the reduction obtained following extension. Allignment 50 per cent overlapping minus 25 per cent contact minus 25 per cent. Rating 50 per cent.



Fig 1T No 1 Feldman, Graduate Hospital, age 30. Comminuted transverse fracture lower third of femur. Picture taken before application of extension.

Fig 1U No 2. Feldman, Graduate Hospital, age 30. Picture taken at time of discharge. Anteroposterior view.

Fig 1V No 3. Feldman, Graduate Hospital, age 30. Picture taken at time of discharge from hospital. Lateral view showing posterior angulation at site of fracture. Allignment 43 per cent, overlapping 25 per cent, end to-end apposition 24 per cent, total 92 per cent.

We have been forced, therefore, to admit that the impression one receives from the literature that it is so simple of application and so easy to

maintain that it is almost fool proof has not been borne out by our experience. That it is possible to obtain the excellent results exhibited by

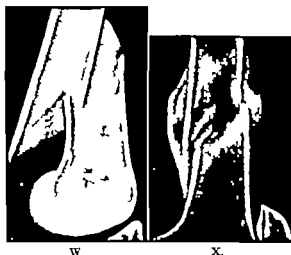


Fig. W No. 1 Coughney Pennsylvania Hospital, 49 years of age. Supracondylar fracture lower end of femur. Picture taken before application of extension. Note the lower fragment is anterior.

Fig. X N Coughney Pennsylvania Hospital, 49 years of age. Picture taken at time of discharge from hospital. Alinement 50 per cent, overlapping 35 per cent, end-to-end apposition 33 per cent, total 97 per cent.

other surgeons has been demonstrated by us in this group of cases, but our results have not been uniform and if this report is to have any value it will consist not only in the exhibition of our failures, but also in the presentation of explanations of these failures. That we have been able to obtain the results reported by others is shown by the fact that 16 of these 51 cases have received a rating of from 90 to 100 per cent of anatomical restoration. Of these cases 7 were from Hospital A in which we consistently found the best results, but there were also 3 cases from Hospital B, 4 from Hospital C and 2 from Hospital D but none from Hospital E.

In the limited time allowed for the making of this survey it has been impossible to study all of the factors contributing to our final results, and we confined our efforts to an estimation of the anatomical restoration at the time of the patient's discharge from the hospital, feeling that this offers the best index of the efficiency of any method of extension or traction.

In estimating the anatomical restoration of these fractures of the long bones we have arbitrarily given 50 per cent for alinement, 35 per cent for end-to-end apposition, and deducted 25 per cent for overlapping.

Using this rating we found that the average anatomical restoration in the five hospitals was 70.5 per cent. The variations in the results in

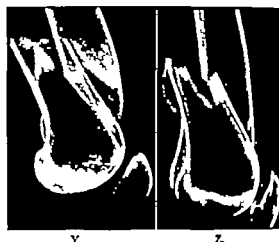


Fig. Y No. 1 Bakumas, Pennsylvania Hospital, 44 years of age. Picture taken before application of extension. Lower fragment is posterior.

Fig. Z No. 2 Bakumas, Pennsylvania Hospital, 44 years of age. Supracondylar fracture lower end of femur. Alinement 41 per cent, overlapping 35 per cent, end-to-end apposition 10.8 per cent, total 58.3 per cent.

the five hospitals is shown by the following tables (Fig. 2)

		Cases	Per cent
Hospital A	90-100 per cent	7	36.9
	80-90 per cent	5	24.9
	70-80 per cent	0	0
	60-70 per cent	0	0
	50-60 per cent	5	24.9
	Under 50 per cent	1	4.3
Hospital B	90-100 per cent	3	60
	80-90 per cent	0	0
	70-80 per cent	2	40
	60-70 per cent	0	0
	50-60 per cent	0	0
	Under 50 per cent	0	0
Hospital C	90-100 per cent	4	90
	80-90 per cent	1	11.5
	70-80 per cent	0	0
	60-70 per cent	0	0
	50-60 per cent	0	0
	Under 50 per cent	3	37.5
Hospital D	90-100 per cent	2	18.1
	80-90 per cent	1	9.1
	70-80 per cent	2	18.1
	60-70 per cent	0	0
	50-60 per cent	4	36.4
	Under 50 per cent	2	18.1
Hospital E	90-100 per cent	0	0
	80-90 per cent	0	0
	70-80 per cent	0	0
	60-70 per cent	2	66.4
	50-60 per cent	0	0
	Under 50 per cent	1	33.6

In an attempt to find more or less constant factors which would be operative in the five institutions and which would account for these variable results, we have analyzed (1) the age of

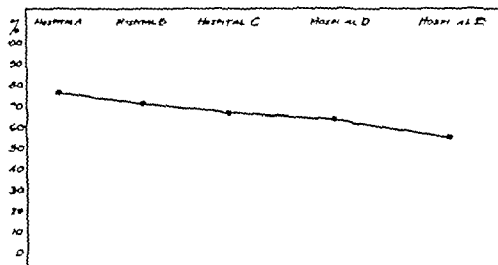


Fig. 2. Comparison of the anatomical reduction obtained by Russell's extension in five hospitals.

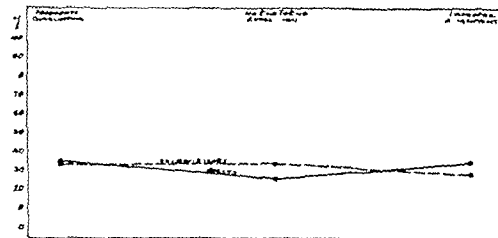


Fig. 3. Comparison of the results in growing and adult bones.

the patients dividing them into two groups, under 18 and over 18, with the classification of adult and growing bones (2) the character of fracture spiral oblique transverse or comminuted (3) the location of fracture intertrochanteric and subtrochanteric, upper third of the femur middle third of the femur lower third of the femur and supracondylar (4) the interval of time between the receipt of the injury and the application of the extension, using 12 hours as the minimum, (5) an estimation of the efficiency of application of the extension according to the principles outlined by Russell, or of failure to maintain these principles subsequent to its application and (6) the premature removal of the apparatus.

It seemed reasonable to divide these factors into two groups first, those over which the surgeon had no control and second those over which he should have had complete control.

The factors over which the surgeon had no control and which in our statistics appear to have

definitely influenced the results are (1) the age of the patient (2) the type of the fracture and (3) the location of the fracture.

The factors over which the surgeon should have had complete control were (1) the time elapsing between the receipt of the injury and the application of extension (2) the efficiency of the application of the apparatus and the success or failure to maintain the principles of Russell subsequent to its application and (3) the premature removal of the apparatus before solidification of the callus.

UNCONTROLLABLE FACTORS

Age Contrary to our expectations there was practically no difference in the anatomical reduction obtained in the growing (69.5 per cent) and in the adult (70.2 per cent) bones. We wish to make clear that this does not refer to the end-results or the functional results but to the anatomical restoration that existed at the time of the

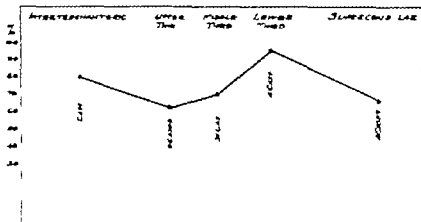


Fig. 4. Effect of location of fracture on anatomical reduction by Russell's extension.

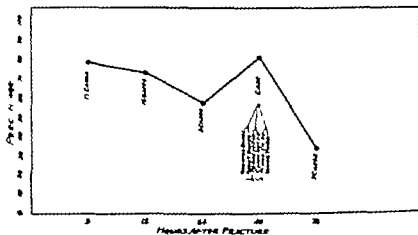


Fig. 5. Effect of time of application of Russell's extension on failure to obtain anatomical reduction.

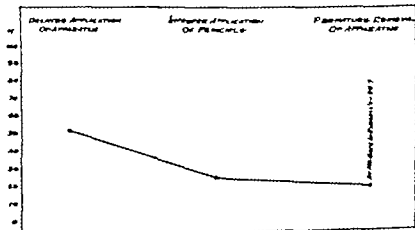


Fig. 6. Causes of failure to overcome overlapping.

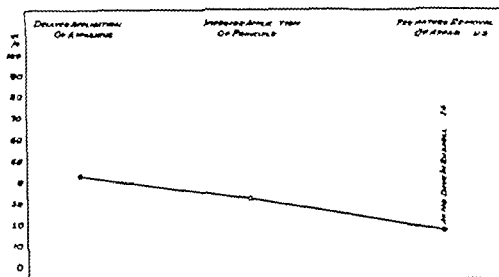


Fig. Causes of failure in obtaining end-to-end apposition.

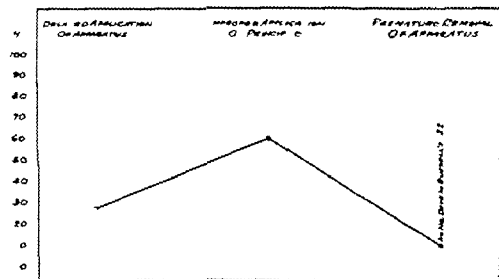


Fig. 8 Causes of failure to obtain proper alignment.

discharge from the hospital. The repeated statements of Ashhurst, Speed, and others, that shortening as a rule may be disregarded in early childhood and of Pfiester that he never saw a fracture in the shaft of the femur of a child that did not give a good result, applies to the final results in all of these fractures in growing bones (Fig. 3).

There is a wide range in the ages of the patients included in this study. The youngest was 4 years of age. His fracture was of the transverse type and was located in the middle third. There was an overlapping of 2 centimeters. Excellent reduction was obtained. The oldest patient was 79 years of age. Her fracture was also transverse in the middle third and had 4 centimeters overlapping. Excellent reduction was obtained.

In the growing bone group, i.e., patients below the age of 18 years, there were 30 fractures. Six

of these were under 10 years of age. There were 12 between the ages of 10 and 15 years. Two cases were 16 years of age. Five of the fractures were in the upper third, and 15 in the middle third. Eleven were transverse, 4 were comminuted, 3 were oblique, and 2 were spiral.

The average time of Russell extension in this growing group was 35.4 days. The average stay in the hospital was 49 days. The final average percentage of anatomical reduction was 69.5.

In the adult group there were 31 fractures. Three were intertrochanteric, 4 in the upper third, 16 in the middle, 4 in the lower third, and 4 were supracondylar. According to the type of fracture, we find 16 were comminuted, 9 were transverse and 6 were oblique. The average time in Russell extension for this group was 37.2 days; the average stay in the hospital, 66.1 days; the final average percentage of anatomical reduction, 70.2.

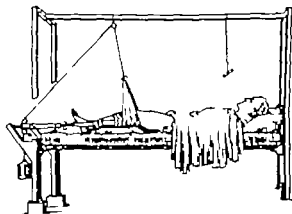


Fig. 9. The R. Hamilton Russell method of extension. (From Brit. J. Surg. 1924-5)

Type of Fracture The best rating obtained was in the spiral fractures, next the comminuted, then the oblique, and the lowest rating was in the transverse fracture (Fig. 1).

Spiral fracture, average rating 95 per cent of anatomical reduction.

Comminuted fracture, average rating 79.5 per cent of anatomical reduction.

Oblique fracture, average rating 69.1 per cent of anatomical reduction.

Transverse fracture, average rating 63.4 per cent of anatomical reduction.

In analyzing the types of fractures in this series we find 5 were spiral 20 were comminuted 9 were oblique and 20 transverse. The two spiral fractures (Fig. 1A and B) were in growing bones and excellent reduction was obtained 95 per cent. The average percentage of reduction for the comminuted group (Fig. 1D and 3U) was 79 per cent, for the oblique (Fig. 1E) 69.19 per cent, and for the transverse 63.48 per cent (Fig. 1I).

Location of the Fracture. In this group of 51 fractures (Fig. 4) 3 were intertrochanteric, 9 were in the upper third 3 in the middle third, and 4 were supracondylar. The best results were obtained in fractures of the lower third of the femur 96 per cent. In the intertrochanteric fractures, 80.3 per cent (Fig. 1C and D) the middle third of the femur 70.97 per cent (Fig. 1Q and R) and in the supracondylar fractures, 63.41 per cent (Fig. 1W X Y Z). The lowest rating was obtained in fractures of the upper third of the bone. Note the wide difference in results obtained in fractures of the upper and lower thirds. The short upper fragment in fractures of the upper third often caused anterior angulation. Excellent results were obtained in the intertrochanteric and lower third types. In one of the supracondylar fractures the distal

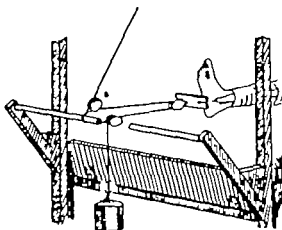


Fig. 10. Details of pulley arrangement at foot of bed. (From Brit. J. Surg. 1924-5)

fragment was anterior and perfect reduction resulted. In the others, however the distal fragments were posterior and unsatisfactory results were obtained.

CONTROLLABLE FACTORS

In analyzing the controllable causes of failure to obtain and maintain reduction we find three main factors were operative. The first of these was delayed application of the apparatus. By this we mean that extension was applied later than 12 hours after the fracture occurred. The second factor was improper application of the principles of Russell's extension. Here the apparatus was not applied properly or it was not maintained properly throughout the healing stage. The third factor was premature removal of the extension. By this we mean that the extension was removed before adequate callus had formed to maintain reduction. Premature removal often resulted in overlapping or angulation.

DEFORMITIES

As noted above we have allotted 50 per cent to proper alignment of the fragments, 25 per cent to full end-to-end apposition, and have deducted 25 per cent for overlapping.

In 19 fractures healing took place with some overlapping of the fragments (Fig. 6). The greatest amount of overlapping was 4 centimeters, the average being 2 centimeters. Seven, or 35 per cent, of these cases were in growing bones and 12 or 36 per cent, in adult bones.

In studying the causes of failure to overcome overlapping we find that in 52.63 per cent of the fractures it was due to delayed application of the apparatus. Improper application and maintenance

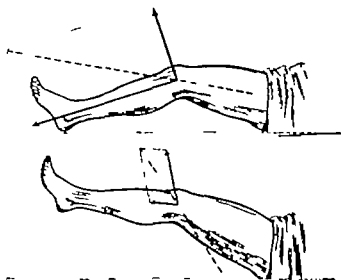


Fig. 11 The direction of forces. (From Brit. J. Surg. 1924-11)

of the principles of Russell was responsible in 26.3 per cent, and premature removal of the apparatus in 21.05 per cent. The average days in Russell's extension was 26.7. The results noted above show clearly the importance of early extension.

In 16 of the total of 51 fractures there was either failure to obtain end-to-end apposition (Fig. 7) or to maintain it after the fracture was reduced. Seven, or 35 per cent, were in growing bones and 9 or 27 per cent, in adult bones.

In analyzing the causes of failure to obtain end-to-end apposition we find again that delayed application of extension was the most important single factor accounting for 43.75 per cent of the cases; improper application of the principle was second with a percentage of 33.35 per cent, and premature removal accounted for the remainder or 18.75 per cent. Average time in Russell's extension was 24 days.

Eighteen, or 39.2 per cent, of the cases of this series presented from 5 to 25 degrees of improper alignment. Six, or 30 per cent, were in growing bones and 12 or 36 per cent in adults. We have calculated the amount of improper alignment in degrees of angulation or deviation of the fragments from the normal weight bearing line. The average angulation was 14 degrees; the deviation 10 degrees. In 15 there was some angulation: 11 posterior and 4 anterior. Ten cases showed some deviation, 6 being external and 4 internal.

In analyzing the causes of the failure to obtain and maintain proper alignment (Fig. 8) we find that delayed application accounted for only 27.77 per cent. Improper application of the principle was the main factor here and accounted for 61.11

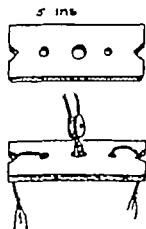


Fig. 12 The spreader used in Russell's apparatus (From Brit. J. Surg., 1924-11)

per cent of the cases. Premature removal of the apparatus came last with a percentage of only 11.11 per cent of the cases. The average number of days in Russell's extension was 22.

In summarizing we find that delayed application was the most important factor in our failures to overcome overlapping and obtain end-to-end apposition of the fragments. Improper application of the apparatus was by far the most common cause of failure to obtain and maintain proper alignment.

It is interesting to note that all of the factors mentioned are easily overcome by adhering strictly to the principles laid down by Russell in his original paper. The Russell method of extension in fractures of the femur is described by him as follows:

The apparatus shown in Figure 9 consists in a sling beneath the knee and horizontal traction on the leg. The arrangement provides that the pull on the leg shall be nominally modified by the friction between the pulleys and cords. The special apparatus required is as follows:

1. An ordinary head-to-foot bar that can be shifted laterally as required. This can be fitted to the ordinary four poster bed, but a more convenient way is to use two uprights, one at the head and one at the foot, securely lashed to the bedstead. The foot of the bed should be elevated to insure counter-extension by the weight of the torso.

2. An arrangement to which may be attached a couple of pulleys beyond the foot of the bed. These pulleys (Fig. 10) should be on a horizontal line with the foot of the patient when the leg is lying horizontally on the pillow with the heel just clear of the bed. A convenient wood or iron bracket can easily be made by the carpenter or the splint maker.

3. Four block pulleys and suitable flexible cord. Application of the apparatus. The use of an anæsthetic is not required in children. In muscular adults we have found spinal anæsthesia to be of the greatest advantage.—(Lee-Veal)

1. The leg, having been prepared in the ordinary way is fitted with a spreader or block close to the sole of the foot by the method similar to that used in Buck's exten-

sion, although there are two important differences. (a) the strapping is not carried above the knee; (b) the spreader is provided with a pulley. A pattern of the spreader which we have found convenient is shown in Figure 12, but its essential feature is that it must be wide enough (5 inches) to deflect the strapping sufficiently to protect the malleoli from pressure. A light bandage over all from the roots of the toes to the knee, is ready.

2. The application of the pulleys (Fig. 9). First pulley *A* is tied to the overhead bar in such a position that a vertical dropping from it shall meet the leg well below the knee. Pulleys *B* and *D* are to be attached separately to the bar beyond the foot of the bed; pulley *C* is attached to the spreader.

3. The knee sling is now placed beneath the knee, which all this time has been lying comfortably on a pillow. The sling should be broad and soft—a soft rough bath towel suitably folded answers well. The ends of the sling are now securely tied together with a cord, which is then passed through the pulleys in the following manner: (a) up to pulley *A*; (b) to pulley *B* beyond the bed; (c) to pulley *C* on the spreader; (d) to pulley *D* (companion to *B*).

4. The surgeon now stands at the foot of the bed and slowly applies extension to the leg and then the weight is attached. He next takes a soft pillow and adjusts it comfortably beneath the thigh to prevent gravitational sagging at the site of the fracture. Care must be taken that the pillow is really soft, a common fault is to have a too hard and tightly stuffed pillow for this purpose. Next he looks to the heel. It must not be touching the bed, and he arranges another soft pillow beneath the leg and the tendon of Achilles to prevent it from doing so. Now the patient will be absolutely comfortable and rest of mind and body (including thigh muscles) will come to him. Finally careful measurements are taken: *f* the lower extremity of the anterior superior spine, the upper margin of the patella on either side.

The usual extension weight required for adults is 8 pounds; for infants and older children $\frac{1}{3}$ to 4 pounds. These weights it will be noticed, are doubled by the pulley arrangement nominally, but in fractures it would seem that there is considerable modification of the pull one way and another, and considerable latitude within the range of efficiency. The truth seems to be that a very moderate pull is adequate, provided it is fairly constant and comfortable. At the end of the third week Russell always seeks to reduce the weight. The surgeon's duty will be to take the measurements at least every morning and evening, and adjust the pillows beneath the thigh and leg so that there is no backward sagging at the site of fracture and the heel shall not be in contact with the bed. Very little is required of him, but while it is very little and very easy yet it is absolutely indispensable and must be faithfully given. The method is far from being fool proof and cannot and will not look after itself. The relation of the fragments should be checked by X-rays until reduction is obtained.

Again quoting Russell

In surveying what one has thus accomplished, we find the thigh muscles are being extended by the combination

of two forces. It is impossible to attain this by a single force acting in a straight line. The diagram (Fig. 11) will make evident the relative action of the forces employed. By constructing a parallelogram of forces it is seen that the resultant force will lie in the line of the thigh. Again, it will be noted that we have apparently taken no measures to secure and preserve good alignment; as bad alignment need never be seen in fractures treated in this way.

In his original report Russell states that experience has shown that the practice presents difficulties and pitfalls that have to be known and recognized and what at first appeared to be small details in the management of the cords and the pulleys turned out to possess unexpected possibilities, and he, in a very valuable way explains the causes of some of the poor results in this series of cases.

The most frequent of all errors, according to Russell is that the foot is too high off the bed. The heel should be almost, but not quite, touching the bed. When the heel is too high a great part of the weight is employed in counteracting the weight of the limb which, of course, subtracts from the extension on the thigh muscles. Upon examining the parallelogram of forces one will clearly appreciate that the horizontal force is diminished as the heel is raised above the level of the bed. Russell feels that this has been a very common error in his application of the extension. Another influence upon the efficiency of the extension and the reduction of the overlapping is in the faulty direction of the upward pull on the knee. If Pulley *A* is wrongly placed nearer to the head of the bed than it should be the result is an upward pull which causes the horizontal pulley to pull against instead of co-operating with it. The position of pulley *A* should be such as to increase the effect of the extension and the change of its position frequently will make possible the complete reduction of the fragments, as in the Hodgen split.

Another cause of failure to overcome shortening and restoration of the normal length of the bone is the use of too much weight. This is most frequently seen in children. If all the conditions which we have outlined, namely, position of the leg and foot in relation to the bed, the position of pulley *A* in relation to the knee joint, are such that the parallelogram of forces is as it should be, but the weight is excessive, we will find that the pelvis is pulled down on the injured side so that the patient lies very obliquely. When the pelvis is pulled downward, the limb is brought into a position of extreme abduction, when sagging of the fragments will occur and there will be shortening of the limb. (Fig. 289 of Russell's diagram, p. 500.)

Finally, the most momentous, according to Russell, of the difficulties is the interposition of muscles, or the thrusting of a fragment through muscle, periosteum or other fibrous tissue and its incarceration in such a way that the end of the fragment cannot be apposed. It is this type of case which he thinks requires immediate operation and open reduction.

Russell claims that there is only one kind of faulty alignment or angulation that is likely to complicate fractures when treated in this way, and that is the gravitational backward sagging at the site of the fracture. This he says is due to the lack of the most ordinary care, namely, the omission of the pillow support to the under surface of the thigh beneath the fracture. In our cases we found that anterior angulation in the upper third has been almost as frequent as posterior angulation in the middle and lower thirds, and although Russell claims that outward or inward deviation is practically never seen, we find that it has occurred too frequently in our group of cases. Our experience has coincided with that of Ridgely and Bongardt, that it is necessary to use more weight than Russell or Ryan employ. Twelve pounds of weight in adults is the minimum.

CONCLUSIONS

From this statistical study of a group of 51 fractures of the femur treated in five different hospitals we feel that to obtain the maximum results from the Russell extension method in fractures of the femur one must

- 1 Apply the extension at the earliest possible moment after the receipt of the injury. After 3 hours the efficiency of the extension is opposed by the contraction of the muscles and the effectiveness of the extension decreases from hour to hour.

- 2 That the extension must be applied exactly as Russell has prescribed.

- 3 That the position of the patient and every detail of the apparatus must be meticulously readjusted as soon as it becomes disarranged. In young children and in restless individuals this may require almost an hourly inspection. This is not peculiar to the Russell extension method, which is really a suspension apparatus for such care is necessary in all methods of suspension

used in the treatment of fractures. In our experience premature removal of the extension has been one of the most serious faults. Although Russell feels that 4 weeks is more than enough, it has not been so in our group of cases, and Lund reports that the average time of extension in his cases was 12 weeks.

- 4 In speaking of the results in any method of treatment of fractures of the femur one must remember that the type of the fracture and the site of the fracture probably have more effect upon the anatomical restoration of the lesion than any method of treatment, and that the spiral, comminuted and oblique fractures in the intertrochanteric region or in the lower third of the femur always give the highest percentage of anatomical restoration. In a review of the literature of the Russell extension method it is surprising to find how many of the reported cases are of these favorable types.

SUMMARY

We have deliberately tried to avoid the expression of personal opinions in this report, but Dr Scudder tells us that in so doing we have failed to understand the object of the symposium. Therefore, for any criticism which we may receive for showing the same weakness that we have condemned in others Dr Scudder must take the blame.

We plan to continue the use of this method in the treatment of fractures of the femur in children beyond the age (4th to 6th year) when Bryant's vertical extension is not applicable, and in the favorable types of fractures in adults, i.e., the spiral, oblique comminuted, fractures occurring about the trochanters and in the middle and lower thirds of the femur. When we find that we are not succeeding we will quickly abandon this method for skeletal traction.

We will not attempt to use it in supracondylar fractures or in fractures of the upper third in muscular individuals.

The unfavorable results which we have obtained should, we feel, be credited to our failure to understand the principles of this method and to appreciate its limitations, and should not in any way be considered as condemning the Russell method of extension.

PATHOLOGICAL FRACTURES

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A PATHOLOGICAL fracture is one occurring from an malignant force acting upon a bone already weakened by disease. It is often spoken of incorrectly as being spontaneous in origin which implies sudden apparent causeless occurrence. Each so called spontaneous fracture however has a definite pathological basis. Each pathological fracture, depending upon its etiology varies as to its treatment and prognosis. Pathological fractures caused by benign or chronic conditions have a favorable prognosis, as a rule, while those due to malignancy and acute suppuration improperly treated, have an unfavorable one.

TABLE I—PERSONAL SERIES

Bone disease	Cases	Per cent	Group	Group per cent
Carcinoma	43	34.6	76	51 Tumors
Sarcoma	5	4.0		
Cyst	1	0.8		
Nidus	7	5.6		
Hypertrophic	1	0.8		
Exostosis	1	0.8		
Scorbut	1	0.8	6	3 Infections
Osteomyelitis	1	0.8		
Lues	1	0.8		
Paget's disease	1	0.8		
Osteoporosis imperfecta	1	0.8	7	16 Nutritional
Rickets	1	0.8		
Osteomalacia	1	0.8		
Hypertrophic	1	0.8	13	104 Miscellaneous
Atrophy	1	0.8		
Osteitis	1	0.8		
Totals	14	100	14	100

ETIOLOGY

Fracture statistics on the whole are deficient in complete analytical figures as to the relative causes of pathological fracture. Many cases originating as osteomyelitis, malignancy, etc. are overlooked or not reported because of the major interest of the etiological disease. Statistics relative to the incidence of disease in causing pathological fractures vary too with the size and type of hospitals. Speed states, for example, that at the Cook County Hospital he sees a large number of pathological fractures due to syphilis each year. His is a much higher figure than are those in smaller hospitals. Until a much larger number of these cases are available for study the knowledge of pathological fractures will be largely individualistic. Table I depicts a personally collected series from two hospitals. From this series it will be noted that bone tumors, benign and malignant, occupy the most important rôle in the production

of pathological fractures. At the same time it is unfortunate that the entire subject of bone tumors is one which is so controversial. Often the diagnosis must be made on the X-ray film, frequently with uncertainty. Indeed, the microscopic diagnosis of a questionable lesion, even in the hands of the best pathologists, is often a difficult one to make. Considerable strides, however are being made by the Committee on the Registry of Bone Sarcoma and others and today much more dependable figures are at hand than was the case when the writer presented this subject three years ago.¹

Speed finds malignant disease to be the most common cause of pathological fracture. This is indirectly confirmed by Christiansen, who, analyzing 1000 cases of bone tumors (disregarding fractures for the moment) found 918 or 91.8 per cent, were malignant (Waring). Judging from the personal series and from the observation of others, it is probably quite safe to say that bone tumors (malignant and benign) are the chief cause of pathological fracture, inflammatory changes second, nutritional disturbances third and neurotrophic changes fourth (Table I).

INCIDENCE OF BONE INVOLVEMENT

The incidence of pathological fracture is found to be greatest in the long bones connected with the trunk. The femur apparently suffers most. The humerus, tibia, and radius are the next most often fractured. The statistics of others approximate the personal ones given below.

In addition to the pure physical causes governing the bone involved, there is also an anatomico-pathological combination that makes for fracture-site incidence. Bone disease, which leads to pathological fracture, is found more often in the long bones than in the flat. The cancellous portions are frequently affected. Certain bone lesions tend to appear in the epiphyseal portions, rather than in the shaft, and consequently muscle action greatest near a joint, accentuates any force upon the potentially weak part.

In an incomplete, personal series, we find the bones most affected by pathological fracture to be as shown in Table II.

Bone metastasis from organic malignant disease may occur in flat or long bones. Flat bones are seldom subjected to trauma, except by direct

¹Eliaeson and Wright, *Surg. Clinics N. America*, vol. 2, 1925.

TABLE II—PERSONAL SERIES

Bone involved	Cases	Per cent
Femur	60	15.1
Humerus	21	10.0
Multiple	8	5
Tibia	7	3.5
Pelvis	6	2.8
Ribs	6	2.8
Radius	3	1.6
Vertebrae	3	1.6
Metatarsals		1.6
Phalanges		1.6
Cervical	1	.5
Ulna		.5
Fibula	1	.5
Mandible		.5
Ox. Callos		.5
Totals	1	100



force while long bones are subject to direct and indirect forces the latter includes torsion and weight bearing as well as muscle play. One seldom sees a pathological fracture of the skull ilium bones of the face carpus or tarsus.

In 13,055 fractures at the University Hospital up to August 1, 1932, the pathological incidence was 0.42 per cent.

AGE AND SEX

Pathological fracture occurs most often in the extremes of life and is determined largely by the disease which predisposes to the fracture. Nutritional defects as rickets and scurvy for example occur in youth likewise do bone cysts, giant cell tumors and osteitis fibrosa cystica. Sarcoma occurs in youth and early adult life more often than in the aged while carcinoma and neurotrophic or atrophic changes occur oftentimes in late middle and advanced life. Acute infectious conditions occur in the first age period—1 to 20, whereas the chronic infections do not discriminate. These factors are more intimately referred to under their respective headings later. It may be well to note at this time that the prognosis as a rule is better in the younger patients than in the older ones. One might even say that the younger the patient and the earlier the disease (with but a few exceptions) the better the prognosis, and the older the patient or the longer the period of the disease the more dubious is the final hoped for result.

CLASSIFICATION

For reference purposes we have classified the fragility of bones under three major headings. Fragility is generally due to a local lesion, a systemic affection, or an hereditary diathesis.

Fragility due to local lesions. Bone cysts. The first under consideration is local cystic disease of bone. Under this heading are included osteitis fibrosa cystica (giant cell tumors, bone cysts, etc.) Blood or dentigerous cysts of the jaw, hydatid

Fig. 1. Left: Bone cyst or osteitis cystica fibrosa with fracture. Boy 8 years old. Insignificant fall. Roentgenogram shows typical lesion of a large bone cyst involving upper third of humerus, through which there has occurred a pathological fracture. The cyst has produced some thinning of the cortex but shows little tendency to expansion of the bone. The apparent trabeculations are evidently fractured portions of the thin bone shell. It begins as a medullary process, is osteolytic, usually single, does not invade the soft parts, and appears nearer the center of the diaphysis than does giant cell tumor, which hugs the epiphyseal area.

Fig. 2. Bone cyst with fracture and union. Same patient as in Figure 1, 2½ years after fracture. The X-ray shows the bone practically restored to normal. There is slight deformity and some increased thickening of the cortex with sclerosis at the site of the fracture. It is interesting to note that the healed fracture site is much farther down the shaft of the humerus than was the cyst 2½ years previously.

TABLE III—CLASSIFICATION

- a. Fragility due to local lesion
 1. Tumors
 - Benign—cysts (osteitis fibrosa cystica), enchondroma, thyroid
 - Malignant—carcinoma, sarcoma, hypernephroma, endothelioma, multiple myeloma.
 2. Infections
 - Acute—Calvé, Perthes, Koebler's, Kummell's, Kleinbock's and Osgood-Schlatter disease.
 - Chronic—tuberculosis, syphilis, Paget's.
 3. Chemical and pressure causes.
- b. Fragility due to general disease
 1. Neuropathic.
 2. Senility.
 3. Osteoporosis of disease.
 4. Osteomalacia, rickets, scurvy, etc.
 5. Metabolic disturbances: diabetes, hyperparathyroidism.
- c. Fragility due to hereditary disease
 1. Osteogenesis imperfecta.
 2. Osteosclerosis (marble bones).
 3. Gaucher's splenomegaly.

and actinomycosis cysts and endochondromata of the phalanges and metacarpals are likewise included by some (French, Waring). Primary cysts will be considered first. Blood cysts are found in degenerating sarcoma (French). Hyda-



Fig. 3A.

Fig. 3B.

Fig. 4.

Fig. 3. Metastatic carcinoma. Woman aged 52 years, primary lesion in the breast with generalized bone and visceral metastasis. Note the "decayed wood" appearance of the lesion before the fracture occurred. A, B shows the fracture 8 weeks after the insignificant trauma. Abundant callus is present and union is solid. Carcinoma of the breast causes frequent metastasis to the bones. It is a destructive process, usually beginning in the medullary canal and gradually increasing in size and destroying the cortex. It may ultimately weaken the shaft to allow pathological fracture. Carcinoma of the breast very frequently causes the osteolytic type of metastasis but it may cause the osteoplastic type.

Fig. 4. Osteogenic sarcoma. R. R., 38, female with a history of pain and swelling in the left lower thigh for 10 months. Osteomyelitis suspected because of the duration. A ray picture showed pathological fracture—diagnosis osteogenic sarcoma. A second picture taken 7 weeks later showed a moderate increase in the area of bone production about the pathological fracture with an increase in the soft tissue involvement about the lesion. Lesion apparently is progressing. No union. Microscopic diagnosis—sarcoma. Osteogenic sarcoma is a malignant disease usually occurring in the large bones, more frequently in the upper tibia and lower femur. It occurs between the ages of 10 and 30 years. It is usually an osteolytic process, beginning in the medullary canal or from the periosteum. It does not cause expansion of the bone but causes destruction. It erodes the surrounding tissues. When it is of periosteal origin, it very frequently causes a perpendicular striation of the new bone formation. The destruction of bone very frequently leads to pathological fracture.

thy cysts are uncommon in America but may be present in individuals who have lived in countries where the disease is prevalent (Russia, Armenia and the East). Such cysts affect the diaphyses of the long bones as a rule and convert the shaft into a thin walled tube which undergoes fracture as a result of slight trauma or muscular action. The existence of such cysts would hardly be suspected unless there were known hydatid disease elsewhere, especially in the liver. Cysts

of the jaw or dentigerous cysts may be the site of fracture. Landolt has pointed out that cysts due to echinococcus, cysticercus, actinomycosis or chronic osteomyelitis of bacterial origin may result in fracture. While fracture through simple cysts often cures such cysts (osteitis fibrosa cystica) fractures resulting from other types of cysts usually require open reduction and curettage. Treatment other than immobilization will depend on the treatment of the causative factor.

Fig 5. Hypernephroma. O K male 59 presenting an old pathological fracture of the left upper femur due to hypernephroma (metastatic). Patient operated upon 5 years previously for hypernephroma of the kidney. Three years later developed pain in the left hip and suffered a pathological fracture. One year later this had apparently united and caused no trouble. Patient admitted for a chordotomy to relieve pain incident to metastasis to the lumbar spine. X-ray examination of pelvis showed an old pathological fracture of the neck of the left femur, the neck of the femur being absent and no union apparent. Metastasis present involving upper femur, pelvis, and lumbar spine. Hypernephroma frequently causes bone metastases. The process is usually destructive and is very similar to that found in metastatic carcinoma. At times, however, especially in the vertebrae, it causes a condensing type of metastasis that may simulate prostatic carcinoma. Still at other times, there are areas of rarefaction and condensation showing a mixed type of cell in the metastatic process.



Fig 5



Fig 6A.



Fig 6B



Fig 7A



Fig 7B

Fig 6. Male, aged 32, with a history of neuralgic pains in his arm and shoulder for 18 months previous. On January 24, 1930, while steering a small car, he suddenly experienced a sharp pain and helplessness in his right arm. His physician diagnosed a fracture and the X-ray examination revealed the above described as a fracture through a bone cyst, myeloma or giant cell tumor. The X-ray picture, A taken 3 months later shows extensive absorption of bone with no regeneration and no union of the fracture. The diagnosis now was sarcoma or Ewing's tumor or giant cell tumor. A cortical lesion diagnosed as bone cyst was discovered in the shaft of the ulna of the same limb; other bones of the skeleton were negative for tumor evidence. The lesion of the humerus was excised and a fibula transplant resulted in an excellent union. The roentgenogram, B was taken 3 years later. The microscopical diagnosis was angio-endothelioma.

Fig 7. Multiple myeloma. The patient, a woman aged 46, was receiving X-ray treatment for multiple myeloma involving the skull. Pathological fracture of left femur followed few weeks later by fracture of right femur while being turned in bed. Union in both limbs. Patient subsequently had pathological fractures of spine, left humerus and left femur, union occurring in all the long bone fractures. Succumbed to bronchopneumonia. Multiple myeloma is a malignant process, usually occurring in individuals between 50 and 60 years of age. It involves, more frequently the spine, ribs, and sternum. It is an osteolytic process, completely destroying the bone, beginning more or less in the medullary portions of the bone but may actually begin in the cortex. When it occurs in the spine, there is a widening and flattening of the vertebrae due to the loss of strain in the vertebrae, and stress and strain of the muscles. Pathological fractures occur very frequently. Multiple myeloma must be differentiated from metastatic carcinoma and parathyroid disease.



Fig. 8. Pathological fracture due to neglected osteomyelitis of 9 weeks duration. Diagnosed hematoma by the first physician. Abscess and fracture resulted. Condition spread to shaft and caused second fracture. Amputation eventually performed. X-ray picture shows a fracture of the surgical neck of the humerus through rarefied area which extend for a considerable distance down the medullary cavity of the bone. A low grade osteomyelitis showing but slight reaction to the infectious process. It is impossible to make an early X-ray diagnosis of acute osteomyelitis as it takes about 10 to 14 days to cause changes sufficient to justify one in making such a diagnosis. One should never wait for a positive X-ray report before making this diagnosis clinically.



Fig. 9. Acute osteomyelitis of femur with pathological fracture. Boy 13 years old. Hurt thigh is football. Incision revealed an abscess, X-ray examination, a periostitis. Three weeks later present picture showed fracture. X-ray shows an oblique fracture at the junction of the middle and upper thirds of the right femur. The periosteum is elevated and thickened and there is an irregularity and mottling of the bone in the region of the fracture indicative of an acute osteomyelitis.



Fig. 10. Syphilitic osteomyelitis of clavicle with pathological fracture. Male, 3 years old. No injury. Fracture painless. Large spleen. Fifty neosalvarsan injections. Secured good union. X-ray examination shows generalized mottling of the involved portion of clavicle with increase in width of the bone due to the accompanying periostitis with new bone formation. Osteomyelitis, due to syphilis, is slightly different from the usual osteomyelitis in that any periosteal proliferation assumes perpendicular striation whereas in ordinary osteomyelitis the periosteal proliferation is laid down parallel to the shaft. Syphilitic osteomyelitis, just as in the other type of osteomyelitis, is a proliferative and destructive process, which is always subject to fracture due to the weakened condition of the bone.



Fig. 11. A, Paget's disease with pathological fracture of femur. Female, 73 years old. While standing, leg goes very slight discomfort. X-ray shows marked thickening of the cortex and irregular areas of bone density widening of the medullary canal and increase in the width of the bone trabeculae. X-ray of the skull will usually confirm this diagnosis. B, Shows union ten weeks after Russell traction treatment. Note the dense callus formation. X-ray shows pathological fracture in the right femur in junction of the middle and lower third. Fragments in good position. Considerable bone callus at the site of fracture. The entire shaft shows diffuse irregular areas of increased bone density. Considerable thickening of cortex throughout. The appearance is that of Paget's disease.



Fig. 11. Sarcoid. J. C., 20 male, hospitalized for the treatment of malignant hypertension. No complaints referable to the hands and feet, though these were swollen, clinically suggesting gout. X-ray examination showed lesion involving the phalanges, metacarpals, and metatarsals chiefly rarefaction. Diagnosis of sarcoid made. Four months later re-examination of the hands showed an improvement in the appearance evidenced by a recalcification especially in those areas previously showing the greatest decalcification. Pathological fracture of the proximal

phalanx of the left ring finger evident at this time. Patient came to autopsy subsequently. Pathological examination of tissue removed from affected bones is typical of sarcoid. Sarcoid is a low grade tuberculous infection involving mainly the bones of the hand and feet, especially the phalanges. It may involve the cortex and medulla. It is necessary for this condition to be differentiated from Yaws or syringomyelia and possibly smallpox. The process is usually in the ends of the phalanges and invades the joints. It is a destructive process.



Fig. 13. Osteochondritis juvenalis femoris girl aged 11. In June began limping. In August an X-ray examination was reported negative. No pain. In December 4 months later while walking on a level pavement, the limb gave way with resultant slight pain. X-ray at this time revealed an epiphyseal separation with diaphyseal bone vacuolization.

tion, A. Left Diagnosis osteochondritis. Roentgenogram B taken 1 year later shows perfect union as well as recovery from the inflammatory condition. Note Examination of the first (August) X-ray film reported negative revealed a "slipping epiphysis with vacuolization or moth-eaten appearance and absorption of the diaphyseal border."

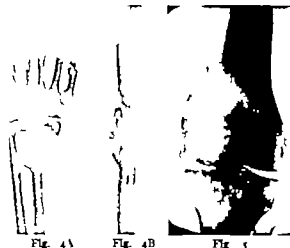


Fig. 4. Giant cell tumor of the lower radius. Male, 49 years old, while receiving radiotherapy had to be splinted indefinitely. Note atrophy of diaphysis of phalanges. Had ulnar neuritis from pressure. X-ray picture shows a large tumor involving the lower portion of the radius. It has the characteristic trabeculated or soap bubble appearance of giant cell tumor. There has been a gradual expansion of the cortex which is everywhere intact. Note the absorption with which the tumor stops in its upper portion, thus indicating its benign character. There is a fracture through the head of the fifth metacarpal, evidently from atrophy of diaphysis. Further note the pressure absorption in the ulna opposite the radial tumor.

Fig. 5. Giant cell tumor. Clinical and X-ray impression was giant cell tumor. This was confirmed at operation 3 months later and the cavity was filled with bone chips. Two years ago the patient fell while bathing and injured the lower left femur. X-ray examination showed a fracture, pathological in nature, through the inner condyle of the lower left femur. Giant cell tumor is usually single, but may be multiple and is a benign lesion. It occurs in the ends of the diaphyses and in the epiphyses, most often between the ages of 20 and 30 years. The lower end of the radius, tibia, and fibula are the usual sites of this lesion. It is a medullary osteolytic lesion which grows gradually and expands the bone. It is frequently found entirely by accident secondary to a pathological fracture. The process expands the cortex and does not invade the soft tissues.

Chondroma or enchondroma. Chondromata of bone are benign though those connected with soft tissues may develop into chondrosarcomata. They usually form at an epiphyseal line and extend distally—expanding widely as they grow (French). The phalanges are the commonest site but the lower end of the femur, the great trochanter and upper end of the humerus, may also be affected. Though usually found in the long bones, Babcock states that they may locate about the hip joint, the neck of the scapula and about the glenoid fossa. They are slow in growth, frequently multiple, and may be peripheral or central. Unless excised, the bone is gradually destroyed and a pathological fracture results. There is no pre-



Fig. 6. Pathological fractures of the neck of both femurs due to Charcot's joints. Male aged 53 years. Slightly painful swelling for one year. No trauma. Walking on arrival. X-ray shows evidence of an old fracture of the neck of each femur with marked upward displacement of the shaft. The acetabula are shallow and rarefied. The head of each femur is flattened and also shows rarefaction. These fractures never unite. The X-ray appearance of Charcot's joint is one in which there are considerable hypertrophic and atrophic changes with loose body formation. The destructive changes and hypertrophic changes are out of proportion to the discomfort of the patient. This process, especially when it involves the hip joint leads to a pathological fracture of the neck of the femur.

dilection as to sex or age except that the lesion does not usually occur after middle life. When the condition is brought to the attention of a surgeon only after a pathological fracture has occurred, it is necessary in the larger long bones to excise the enchondroma prior to immobilization before union will take place. Shortening may result in small bones, as the phalanges.

Osteitis fibrosa cystica. By far the greatest number of pathological fractures due to cystic disease of bone is the result of osteitis fibrosa cystica. About this term and several others connoting the same condition (osteitis fibrosa, fibrous cysts, bone cysts, cystic disease of bone, fibro-cystic disease of bones, von Recklinghausen's disease, etc.) lies a certain amount of confusion. Geschickter and Copeland have recently clarified the situation somewhat. They have reviewed 400 cases of bone tumors of the giant cell group, including giant cell tumor, osteitis fibrosa, solitary bone cyst and are of the opinion that the three are one and the same condition in different stages and all due to trauma. The condition occurs most often in youth and at the metaphyseal regions of the long bones, chiefly the humerus, femur, tibia, and radius. A fracture from slight violence is frequently the first intimation of trouble. The X-ray findings are characteristic (Fig. 7). The fracture is not very painful is often

Fig. 17 A, United pathological fracture of neck of femur due to osteomalacia. Female aged 23 years. Fractured hip when 9 years old and femur when 19 years of age. Concave cortex is thick. X-ray film shows an old united fracture of the neck of the femur with consequent deformity of the hip joint. There is marked decrease in density and a loss of the normal bone trabeculations as compared with the opposite femur. B The shaft distal to the trochanters shows bowing with thickening of the cortex on its entire inner aspect evidently the result of faulty weight bearing in an osteoporotic bone.



Fig. 17 A



Fig. 17 B

Fig. 18. Rachitis. C. P. male child, 29 months old, with a pathological fracture of the shaft of the left femur due to rickets. Normal delivery bottle fed baby no cod liver oil or viosterol. Walking delayed until age of 2 because of a club-foot, present at birth. Injured left limb from trivial trauma at play. X-ray film showed typical signs of rickets. Treated by suspension, Bryant's method. Good union in 1 month. X-ray film on discharge showed evidence of healing rickets in both lower extremities. This is a deficiency disease of the bone. The process is osteolytic in type involves multiple bones. It is usually seen in children after the age of 4 months and is supposed to be due to vitamin deficiency. It is a benign process which heals by regulation of the diet and vitamins. When fractures occur they usually occur near the epiphyseal line where the (Rickets) bone is weakest due to the osteoid tissue. The X-ray appearances in a typical active case shows disappearance of the center of ossification in the epiphyses, widening and cupping of the diaphyseal end which expands with the enlarged epiphyses, osteoid zone at the ends of the diaphyses and disappearance of the zone of temporary calcification.



Fig. 18.



Fig. 19.

Fig. 19. Hyperparathyroidism. The photograph is that of the lower extremity of a young man, from whom on three occasions a parathyroid adenoma was removed. The patient has had countless fractures over his entire skeleton. The X-ray film shows the pronounced widespread decalcification and oftentimes a pathological fracture. The patient did not have a recent fracture at the time of this exposure.



Fig. 20A



Fig. 20B

Fig. 20. A. Multiple pathological fractures of right femur and bones of both legs due to osteogenesis imperfecta. 1 month old girl one of twins. Both suffered similarly. X-ray film shows marked deformity of both lower extremities due to multiple fractures of the femora and tibiae. All the bones show the generalized decrease in bone density characteristic of osteogenesis imperfecta. It is an osteolytic process evidenced by decreased density of the bones, thinning of the cortex, and multiple fractures. The fractures unite with considerable external callus formation. These twins had been on orange juice and milk under the supervision of children clinic previous to admission with the fractures. In the hospital the treatment consisted of orange juice, cod liver oil, heliotherapy and traction. B. Sixteen months after intensive treatment. Both twins had no further fracture for 3½ years. X-ray film shows practically normal lower extremities. The deformities have disappeared, there is little or no evidence of the previous fractures. Note the marked increase in bone density.



Fig. 21

Fig. 21. Gaucher's disease. Female aged 9 years, was observed over a period of 4 years during which five pathological fractures were treated. At the age of 5 child was hospitalized with a fracture of the upper right tibia and of the left femur. Satisfactory union. Tentative X-ray diagnosis, Gaucher's disease. At the age of 6 years, had fracture of neck of right femur, satisfactory union. At the age of 7, child again had pathological fracture of the neck of the right femur while walking. Union satisfactory but considerable lateral bowing followed this injury. Child was treated by diet and plaster during this period. Fracture of the left humerus 1 year of age, good union. At present there is considerable anterior bowing of left humerus and the right leg which is shorter than the left shows marked anterior bowing of the femur. X-ray studies of the skull show diffuse areas of rarefaction and areas of increased density the lesion increasing steadily. The blood calcium is 0.5 milligramme.

communited although with little overriding, and union occurs usually with a resultant cure of the cystic condition. Follow up reports have shown, however, that at least in some cases of fracture, irradiation has given the most lasting cures, probably because of parts of the cyst having escaped the curative trauma of the fracture.

Metastatic carcinoma (Fig. 3 A and B). Carcinoma of bone is metastatic, or the result of invasion from an overlying tumor. It is well known that carcinoma, especially of the breast tends to produce bone metastases. Carcinoma of the stomach may also give rise to secondary deposits in the bones. Waring found that metastasis to bones occurred in 53 cases (4.6 per cent)

of 1,144 autopsies upon cancerous patients. Of the 53 cases 34 (64 per cent) were carcinoma of the breast primarily. The first signs of malignant disease may be osteoporosis, erosion, and fracture although pain frequently calls attention to its condition. Usually more than one bone is involved. Unlike sarcoma, the bone lesion is rarely large enough to command attention and the growth is slow. A moth-eaten or "decayed wood" appearance with a compensatory periosteitis results. The common sites for metastases, with fracture are the femur, humerus, ribs, and sternum. Handley (Speed) in 329 cases of carcinoma of bone, due to metastasis from carcinoma of the breast found the bone incidence as follows

	Per cent
Sternum	9.0
Ribs	8.0
Femur	4.2
Spine	3.6
Humerus	2.7
Cranial bones	2.7

Handley states that in carcinoma union is the rule. Pancoast estimates that union occurs in probably 40 per cent of these cases with or without radiation.

The prognosis, of course, is very poor, as with other malignant bone affections. The local lesion causing the fracture is only an incidental part of the generalized malignancy. The prognosis is similar to that in sarcoma of which Ewing remarks "The surgical treatment of bone tumors is highly unsatisfactory. Amputation is seldom indicated from a curative point of view as it may be indicated in early cases of sarcoma. It may be performed for the patient's benefit to shorten his hospitalization and to free him from malodorous dressings disability and pain."

Sarcoma (Fig. 4) Sarcoma of bone is usually primary and of the osteogenic type. Pathological fractures occur and union after fractures is possible, but rare (Babcock). Waring has seen union occur, but Bloodgood has seen only one case in which union occurred and one other questionable case. Pancoast has no case of union in his files. Pfahler recalls no case with resultant union. Meyerding (see Waring) analyzing 109 cases of sarcoma involving bone found the different types to be as follows

	Cases
Mixed celled sarcoma	51
Osteosarcoma	19
Chondrosarcoma	17
Round cell	14
Fibrosarcoma	8
	109

Waring classified sarcoma of bones into periosteal sarcoma and endosteal or central sarcoma. The first should not be confused with parosteal sarcoma which is sometimes termed periosseous fibrosarcoma. This latter is not a true bone tumor, but lies adjacent to bone and may by pressure affect bone without invading it.

Periosteal sarcoma is more common than endosteal. The metaphyses of long bones is the commonest site. Seventy two per cent (Babcock) involve the lower extremity and 82 per cent of these occur near the knee. The shoulder girdle is next in frequency. The humerus is usually attacked above the deltoid tubercle the scapula in its glenoid cavity or spine and the clavicle

in its outer one half. Other bones may be involved, but are seldom fractured. The fact that the lower epiphyseal end of the femur and upper epiphysis of the tibia are the last to ossify may explain the predilection for this area (Babcock).

Trauma is said to precede 50 per cent of cases of osteogenic sarcoma and the tumor to develop within 1 month after injury in 30 per cent of cases. The bones concerned in the formation of the knee joint and shoulder girdle likewise receive a large share of trauma in the young among whom it most often appears. Strangely enough the lower end of the radius (though often injured) is rarely affected and there is no record of the distal end of the ulna ever being involved.

Males are affected in the proportion of 3 to 1 though females predominate during the first decade of life. Sarcoma of bone occurs chiefly in childhood before the age of 20 years and is rather rare after the age of 40, except where it is secondary to Paget's disease. According to Codman (Babcock) 14 per cent of all patients with Paget's disease die of osteogenic sarcoma.

The X-ray picture of the lesion is generally characteristic. There is a fusiform swelling or spindle contour at the end of the bone. The joint or epiphysis is not invaded. The periosteum becomes markedly elevated with a thickened 'lipping' of its margin. In 18 per cent there may be noted fanlike radiations which give it the so-called 'sun rays' appearance. Expansion of the shaft rarely takes place. The spindle mass is caused by penetration of the bone by the tumor and the formation of a mass around the shaft.

Treatment is more hopeless when a pathological fracture occurs than otherwise. By the time the surgeon sees the case the resulting trauma to the tissues has opened the blood and lymphatic vessels thus predisposing to metastasis. The mixed toxins of Coley, irradiation and amputation, are reported to have cured some cases of sarcoma but rarely so when fracture occurs. Cases thought to be cured of their local lesion by irradiation generally die later from metastasis. By the time the bone is involved sufficiently to result in fracture, dissemination has either begun or occurs with the injury to the tissue at the time of fracture.

The writer has successfully treated 2 cases by amputation. One was in the distal portion of the femur and one in the tibia. Both diagnoses were proved by the microscope. One case is alive at the end of 18 years and the other at the termination of 12 years. There is no doubt that amputation is of value only when the condition has just begun and when it is distally located. A high amputation

may then be successful. Coley has recently reported 2 cases of the endothelioma type with apparently successful cures by operation and the use of Coley's fluid. One patient was well 3 years later and the second $4\frac{1}{2}$ years after. Coley and Sharp state that fracture through osteogenic sarcoma shortens life expectancy 60 per cent.

Statistics show (Ewing) that nearly all osteogenic sarcomata prove fatal and while recovery seems to have occurred in rare cases "this fortunate outcome is the meager fruit of large numbers of useless amputations." However amputation in many instances has its advantages. It shortens the hospitalization of the patient. It relieves the patient of an incapacitating, often painful frequently ulcerating, foul smelling lesion requiring painful dressings. Furthermore, after such operations patients have been known to live with comparative comfort for many months despite the presence of visceral metastasis (lungs) at the time of operation.

Endothelioma (Figs. 5 A and B) An endothelioma is a tumor originating from endothelium and resembling both sarcoma and carcinoma. It forms about 7 per cent (Babcock) of the sarcomata of bone.

It affects the long bones more often than the flat. The most common sites are the tibia, fibula, humerus, ulna and the femur. Other small bones of the feet, ribs, vertebrae etc. may be affected. In the latter locations it must be differentiated from multiple myelomata. The tumor widely involves the shaft of the long bones or starts in multiple areas. The tissue itself is soft mushy and whitish gray. While it destroys bone a regenerative process likewise takes place at the periosteal borders. Various layers are formed in the course of time giving the roentgenogram the peculiar appearance termed 'onion layer' (Babcock).

The disease frequently follows trauma and is usually one of youth, 50 per cent of the cases occurring before the age of 15 years. Because of the pain, limitation of motion, slight fever and leucocytosis, it may be mistaken for osteomyelitis. The joint is seldom involved and pathological fracture occurs late.

Metastasis via the blood or lymphatic stream occurs with great rapidity in the lungs, skull, various bones, liver, spleen, and regional lymph nodes.

The prognosis is very poor as death generally occurs in from 6 months to 2 years. The disease is very sensitive to irradiation.

Treatment consists of immobilization and possibly irradiation. Union may occur as temporary

improvement or retrogression takes place with radiotherapy. If the condition occurs in an extremity and is recognized before metastasis takes place, amputation in our opinion should be done.

Hypernephroma—metastatic (Fig. 6) Hypernephroma is now considered to be a malignant adenoma or adenolipoma of the kidney. It occurs generally in young girls and in adult men. The condition is extremely malignant and metastasis occurs via the blood stream to the liver, lungs, and bones. The bones most often affected are the skull, humerus, and femur. Cases have been recently reported by Mazzini, MacKechnie, and by Broster. Rapid recurrence generally follows extirpation of the original tumor. Excision or amputation, when pathological fracture occurs, offers no hope of cure. Death usually occurs in from 2 months to 2 years. Radiotherapy and Coley's fluid may be tried. The prognosis is more grave than that of a pathological fracture due to sarcoma.

Thyroid—metastatic. Bloodgood states that the majority of these lesions are metastases from a malignant adenoma of the thyroid gland although other authorities consider the condition non-malignant. Blumer has analyzed the reported cases and finds that 38 per cent occur in the bones of the face and cranium, 16 per cent in the vertebrae, and only 15 per cent in the long bones—hence fracture is comparatively rare.

Multiple myeloma (Figs. 7 A and B) Myelomata, in comparison with the single benign myeloma of bone, are multiple malignant, and subject to metastases. Fortunately the condition is rare (Waring). The bones most commonly affected are the ribs, sternum, vertebrae, cranium, ilium, and (very rarely) the long bones of the upper extremity. Often the first symptom is pain in one of the areas most affected. As the disease progresses metastases take place in other bones. When the spinal column is affected the pressure on the cord may resemble that of a spinal cord tumor. Pathological fracture is seldom seen as the flat bones are oftenest involved. Anemia is sometimes present. Males, generally between 4 and 60 years of age, are most likely to be affected. The prognosis is very poor as death usually occurs in a few months. Surgery or radiation is of little value because of the widespread metastases. Treatment is directed to immobilization, sedatives, and attending complications. Union does occur proved by the case illustrated in Figure 7.

Infections. The infectious diseases of bone leading to pathological fracture are subdivided into the acute and chronic.

Acute pyogenic infections (Fig 8) Acute osteomyelitis may form a localized abscess involving a large portion of a bone and lead to fracture. As a rule however more extensive destruction takes place with a resultant periosteitis, necrosis, sequestrum formation, and pathological fracture. The first two decades of life (males particularly) are probably more often affected than any other. The condition is sometimes erroneously diagnosed rheumatism subdeltoid bursitis, etc. This is understandable when X rays taken at the beginning of pain may be negative for bony pathology. The treatment is essentially that of an infected compound fracture, namely adequate drainage plus immobilization. When such cases come to the surgeon early the prognosis is good. In neglected cases, non union may occur, particularly when improper splinting has been applied. Union is the rule in pathological fractures due to acute osteomyelitis where early drainage has been secured. Excessive callus is often seen.

Chronic infections—syphilis (Fig 10) Syphilitic disease of bone *per se* is seldom a cause of pathological fracture. Such fractures though, occur fairly often in patients with cerebrospinal syphilis.

The local affection of bones is generally a periosteitis which results in a thickened cortex and osteosclerosis. Nodular swellings may occur as in saber shin. Subperiosteal gummata may destroy bone and weaken it sufficiently to cause pathological fracture. This is particularly true where an ulceration or infection is engrafted upon a secondary osteomyelitis. Constant has reported pathological fractures of the femur due to syphilitic osteomyelitis. Sihol has reported a similar case with recurrence. Achard and Walter have made a study of clavicular fractures in syphilis. Figure 10 shows a personal case.

Chronic infections—tuberculous osteomyelitis These affections are often seen in the phalangeal tarsal, and carpal bones of children as strumous dactylitis. There is a localized fusiform swelling of a phalanx or metacarpal bone, caused by a tuberculous caseous process that breaks through the cortex. In adults, a diffuse thickening from periosteitis and the formation of a central sequestrum occurs. With necrosis, a pathological fracture may take place.

The disease attacks long bones in the region of the epiphyses. The short long bones are usually affected nearer the shaft center. The femur, tibia, humerus, and bones of the forearm are the ones most often fractured. The ribs may be invaded by extension. Lenormant has reported pathological fractures of ribs in tuberculous osteitis.

In America the condition is on the wane, due no doubt to better milk laws. Innumerable cases of tuberculous osteomyelitis still occur in Turkey, the Balkans, and southern Russia, where the majority of cows are affected with bovine tuberculosis. The condition occurred most often before the age of eighteen.

Chronic infections—osteitis tuberculosa cystica multiplex (sarcoid) (Fig 11 A and B) In this disease tubercle bacillus is the etiological factor. It manifests itself in typical skin lesions or in typical bone lesions, or in both. All the lesions are painless. Emaciation and weakness are pronounced. The bone lesions are limited to the hands and feet, chiefly in the phalanges but they do occur in the metatarsals and metacarpals. The X ray changes consist of a slowly progressing alteration in the trabecular formation of the bone, followed by actual bone destruction, either central or cortical or both. In another type the lesions begin as punched out areas sometimes extending entirely through the phalanges. Complete destruction is most likely to occur in the terminal phalanges. The disease is a chronic one and the tubercle bacillus is not always found nor is caseation ever present.

Sufficient information is wanting upon which to make any statement as to the incidence of union in pathological fracture in this condition.

Chronic infections—Paget's disease (Fig 12 A and B) Paget's disease is a condition of unknown origin and very likely due to an infectious process. It is a chronic, progressive, and symmetrical disease affecting chiefly the long bones, skull and spine. Early hyperemia, bone absorption and softening take place. These changes are followed by bending, thickening, sclerosis and a tendency to sarcomatous change.

According to Babcock the marrow first becomes vascular and the bone, rarefied and partially decalcified bends under pressure. Later excessive bone formation occurs with calcification and sclerosis. It is during this latter stage that pathological fracture is most apt to occur.

The curved legs, bowed knees, kyphotic spine, and anthropoid carriage attest the progress of this incurable disease. The femur and humerus are the bones most liable to fracture. The fracture line itself is characteristic, and generally is clear cut, transverse or of the "step type." Union occurs but is slow and prolonged immobilization is required. Excessive callus is the rule.

The progress is favorable as far as eventual union is concerned, but it is grave inasmuch as 14 per cent (Codman) of the patients die of a secondary osteogenic sarcoma. "If there were

non union of a fracture in a bone, evidently an example of Paget's disease. I should be suspicious of secondary sarcoma and amputate at once (Bloodgood). The presence of osteogenic sarcoma in later life is almost presumptive evidence (Babcock) of Paget's disease. Recurrent fractures are apt to follow.

During the progress of the general disease the skull becomes extremely thick and the intracranial space decreases. As a result, severe headache, cerebral pressure symptoms and mental deterioration take place. In the elderly, softening of the fractured ends may develop into sarcoma.

No cure for Paget's disease has been discovered. Parathyroid thyroid calcium therapy and irradiation have been tried with indifferent and variable results. As the condition is often ushered in with a slight fever, dull aching pains, and hyperplasia of bones it is not without hope that some one may yet discover an infectious agent to be its cause and a subsequent cure result.

Fragility due to infection of epiphyseal areas (Fig. 8 A and B). The following conditions fall into this category:

Osteochondritis deformans juvenilis coxae results in pathological separation of the epiphysis of the head of the femur (slipping epiphysis) and produces deformity and shortening unless detected and treated early. Immobilization in a Whitman cast and prevention of too early weight bearing afterward suffice for a cure. The prognosis is good.

The slipping tibial tubercle described by Osgood and Schlatter and seen most often in rapidly growing male adolescents, might well be grouped here. The condition is readily recognized if one is on the look out for it.

Kochler's disease, Kummell's disease and Keinboch's disease might be classed as pathological fractures if we consider trauma as the etiologic factor.

Local pressure (Fig. 14). Local pressure on bone may lead to necrosis and subsequent pathological fracture. Some of these causes are: Pressure upon a contiguous tumor, pressure upon ribs, sternum, or vertebrae, pressure from a tight encircling wire or metallic band. The treatment consists of removal of the cause when such is possible. A personal case is recorded in which the fracture was due to pressure necrosis resulting from the application of a Parham-Martin band in another hospital. Garr has reported a similar case. Kilgore and Chamberlain have reported "fibrosarcoma of soft parts causing pathological fracture of the femur and giving an X-ray ap-

pearance of periosteal sarcoma." A double fracture of the mandible predisposed by an impacted molar has been described by Crick.

Fragility due to general disease *Neuropathic* (Fig. 16). There are certain diseases affecting the central nervous system in which pathological fractures occur. The most common are tabes dorsalis, paresis, syringomelia, spina bifida, hemiplegia, and infantile paralysis.

The exact cause of predisposition to fractures in these conditions is not as yet known. No doubt there are several. It is known that injury to a nerve supplying a part causes trophic disturbances. An atrophic bone readily fractures. Allison and Brooks have shown that bone atrophy of disuse is a quantitative rather than a qualitative chemical change. The chemical constituents of the bone making for strength and elasticity are deficient. The bone is fragile and it breaks easily. Other accessory factors, such as loss of pain and sensation, weak, atrophic musculature and hypoplasia of bone may play a part.

Neuropathic—tabes dorsalis and paresis. The greatest number of pathological fractures in syphilitic patients occurs in tabetics and in paretics. According to Speed "the nervous system also has on bone an influence which predisposes to fractures. Neurotrophic influences in insanities, in paralyzes, and particularly in tabes must be considered. In the Cook County Hospital there are each year 12 to 15 cases of pathological fracture or fracture dislocation in tabetics. They are usually near the joints, accompanied by much bone change of a rarefying or hypertrophic character of typical Charcot joints, and are quite painless. Some patients present three to five fractures at the same time."

Cotton is of the belief that "fractures in tabetics are hardly spontaneous; they depend on inordinate but powerful muscle action (as in fractures due to feats of strength) for contrary to the common statement, the bones of tabetics are apt to be heavy and hard rather than atrophic."

Pathological fractures in paresis usually occur late in the disease when these patients are bedridden and their paralyzed extremities are in an atrophic stage. False claims (French) of rough handling by attendants may be made. The femur is probably most often affected, occasionally the clavicle may also be affected. The diagnosis rests partly upon the history, physical findings, blood or spinal Wassermann test, and the X-ray picture.

Treatment consists of proper immobilization, active antisyphilitic treatment, including large doses of iodides (Babcock) and drainage or dressings in cases of a "mixed infection" osteomyelitis.

The prognosis is good as a whole particularly where the disease is local. Speed agrees that most tabetics even with Charcot's joints, heal though with deformed, but nevertheless functioning, joints.

Neuropathic—syringomelia Fractures in this condition are usually observed in the upper extremities while tabes which simulates it somewhat generally causes fractures in the lower limbs. The patient may not recall any traumatic cause, being insensible to pain. Schultzer reports a baker who fractured his arm during ordinary kneading of dough. The patient felt no pain, but the crepitation and shape of his arm attracted his attention. A patient of Bernhard's also sustained a fracture of the ulna while at work but continued to break stones. The next day he even carried water before consulting a doctor. Schlesinger reports a woman who heard a crackling sound while turning a bed cover. She then found that she had fractured both bones of her forearm. Schultzer finds curiously that the right side is seldom affected and the lower extremities rarely.

The fractures are apt to occur only in the late stages of syringomelia. Normally they heal quite rapidly or may require a long time and pseudoarthroses may form. The callus may be normal in amount or superfluous. It is the opinion of Schultzer that because of the loss of pain and muscle sense the patient may not be aware that he is subjecting his muscles to any excessive strain. Similar instances are seen in normal individuals performing feats of strength. Recent articles regarding pathological fractures occurring in this condition have been published by Koch and others.

Neuropathic—spina bifida Pathological fractures in the lower extremity have been noted in cases of spina bifida. Its occurrence is not common. Its cause is attributed to bone atrophy as a result of the involvement of the lower spinal nerves in the meningocele. It may, however, be due to atrophy of disuse where the lower limbs are paralyzed. Where the neurotrophic condition has affected the growth of the bone, hypoplasia of bone rather than atrophy may occur. An 8 year old boy under our present care illustrates this.

Neuropathic—hemiplegia Fractures due to bone atrophy and disuse usually occur in elderly hemiplegics. Often they are bedridden, though a defensive movement in an ambulatory case may result in fractures. The site of fracture is usually the anatomical neck or upper shaft of the femur. Occasionally the humerus suffers. Experience has taught us that the usual treatment of the past

(plaster cast) is often inadvisable. As a general rule, the Russell apparatus is the most satisfactory treatment for fractures of the femur. It is best to keep the patient in semi Fowler position.

The reasons that have led us to adopt this form of treatment are. The frequent occurrence of hypostatic congestion and pneumonia, and decubitus in cases treated with a plaster cast, difficult nursing care delayed or non union in many cases, regardless of the form of immobilization and finally economical and functional considerations. The patient is elderly and bedridden. The extremity is paralyzed and functionless, with or without union. Why then restore bony alignment in a paralyzed extremity at the cost of life from complications? The time will come when useless limbs will be amputated.

Neuropathic—infantile paralysis In either in infantile spinal paralysis or the cerebral paralysis of children the growth of the bones in the affected extremity does not keep pace with the normal side. Bone hypoplasia and a retardation of bone growth may accompany bony and muscular atrophy. Willard mentions bone atrophy following poliomyelitis. Haxson and his associates have reported a number of cases. The question is unsettled as to whether the lack of regenerative power of bone in cases of paralysis is due to disuse or trophic disturbances. Putzu found experimentally that nerve trunk lesions have no effect on the formation of callus. Others have reported differently. Allison and Brooks show the effects of disuse in the production of bone atrophy. Tumpeter and McNeely have recently reported 2 cases of fractures in poliomyelitis.

Delayed union and refractures are apt to occur.

Osteoporosis of disuse Osteoporosis of disuse is essentially bone atrophy due to prolonged immobilization or insufficient motion in a part. Bone stability is apparently due to proper nutrition supplied by an adequate circulation or tissue respiration. When either of the latter is interfered with, decalcification results. Hypomotility decreases tissue respiration. This condition is frequently observed in extremities that have been overimmobilized or have not functioned because of paralysis. It is encountered in the extremities of hemiplegics, infantile paralytics, deltoid musculospiral, and circumflex paralysis etc.

The prognosis is good if there is no accompanying nerve paralysis, though in the aged senile changes, etc. must be remembered. As a rule, early mobilization, diathermy, baking, massage and passive motions bring a good result. An unusual case is that of a young man (distal end of fifth metacarpal) who developed a pathological

fracture of his fifth metacarpal as a result of prolonged immobilization of the wrist (and possibly from nerve pressure) while being given radiotherapy for a giant cell tumor of the lower end of the radius.

Osteomalacia. (Fig 8 A and B) Osteomalacia is an abnormal softening of the skeletal system. It affects adults primarily. So called juvenile osteomalacia as a rule is osteogenesis imperfecta, with which it is often confused. In America, osteomalacia occurs most often in lactating women and is fairly common among those (Italian and Austrian) who are often pregnant, have a poor diet, and suckle their young for 1 to 2 years believing pregnancy can be avoided thereby.

War and famine osteomalacia was observed very often among the Central Powers during the great war. Maxwell (Peking, China) claims that osteomalacia is seen more often in India, Kashmir and Northern China than in any other countries. In the latter place there are at least 40,000 to 50,000 cases, mostly found in the uplands of Shansi and Shensi, in the middle belt of Kansu and in Manchuria. It is occasionally found in isolated cases all over the Republic of China. Hunger or starvation osteomalacia, as it is also called, is due to a long continued improperly balanced diet. Lack of fresh foods containing vitamins and absorbable calcium has been found to be the cause. Recently we have observed this condition in a 28 year old female dietitian who, through voluntary dietary restriction to make herself thin so succeeded that her tissues were those of a case of rickets. She was nearly 6 feet tall and weighed only 100 pounds. She was devoid of subcutaneous adipose tissue and the osseous system was quite porous. The fracture sustained was an intracapsular one of the femur with practically no pain. She has made an excellent recovery through immobilization, diet, and ergosterol.

The condition when due to famine affects naturally both sexes and all ages. The diagnosis is generally made by X-ray. When the disease has progressed for a long time before fracture bowing of the femora and pelvic deformity may be physically observable. The roentgenogram of the fractured and other bones reveals osteoporosis. The degree of bone porosity varies with the stage or severity of the disease. The bones are lacking in calcium and the blood content of calcium may be as low as 5 to 6 milligrams (Mills and Feng). Bending of the long bones is often noted. It is due to weight bearing and bowstring muscle action.

The prognosis is favorable although union may be delayed if metabolic needs are not appreciated

and refracture may occur for the same reason. In addition to immobilization, treatment should be directed to the causative factor. In the case of *famine osteomalacia*, a normal diet should immediately be given. It should be reinforced by articles that can quickly make up the deficient bone regeneration. Food products rich in vitamins C and D should be given. These consist of milk, codliver oil, egg yolk, orange and lemon juice, apples, and bananas.

Administration of parathyroid (Collip) may be given a trial. New calcium, easily absorbable, must be supplied by diet. Codliver oil, viosterol, ergosterol, ultraviolet rays, or sunshine, aid in better calcium absorption and deposition. In lactating or pregnant women it may be advisable to terminate lactation or pregnancy and immediately institute the calcium-increasing treatment outlined. The fetus in osteomalacia suffers with the mother. Osteoporosis and a diminished amount of calcium in the blood and umbilical cord are generally found. Maxwell, without terminating pregnancy has been able to treat an expectant mother, cure her during gestation and normally deliver her of a normal child. He uses diet, codliver oil, and irradiated ergosterol.

Cases due to starvation or underfeeding have been reported by Simon, Steiner, Hahn and by Arenas.

Rickets (Fig 18) Rickets is observed most often in infants, but it may persist to adolescence. It is due to the lack of vitamin D. Negro children are probably most often affected. It is a hypovitaminosis due to a poor diet on the part of the mother or an improper baby formula. In infants the fontanelles delay in closing. A rachitic rosary is often present. The epiphysis and joints are enlarged. Curving of the long bones results. The bones are deficient in calcium and phosphorus and often contain an abnormal proportionate amount of magnesium and sulphur. The bones are fragile because they are soft. Fractures are similar to those in osteogenesis imperfecta. The X-ray reveals, however, cupped epiphysis in addition to bone porosity. Multiple fractures and recurrent fractures occur when the condition is not recognized or vigorously treated. The prognosis is good under proper treatment. Excessive callus is often the rule.

The treatment consists of proper immobilization and attention to diet and vitamin requirements. If the baby is still nursing it should be taken from the breast and placed upon a proper formula. Orange juice, codliver oil, ergosterol, viosterol, etc. should be added. Schilowetz has demonstrated that avitaminosis retards the for

mation of callus. When available sunshine and ultraviolet irradiation are extremely beneficial. Scurvy may attend the condition as it did a recent one of our own.

Scurbulus Scurvy may occur at any age and in either sex. It is a hypovitaminosis and occurs when the diet is lacking in vitamin C. Imperfect osteogenesis results. Wasting, diarrhoea, mucosal hæmorrhages, periosteal proliferation and osteoporosis are manifestations of the condition.

While it may occur among sailors, hunters, and explorers who exist largely upon canned or dried foods, pathological fractures occur most often in infants and the young. The skull ribs, costochondral junctions and long bones are mainly affected by the disease. Fractures occur, as a rule in the thigh, leg and upper extremity. The diagnosis is made physically and by the X-ray. In the latter subperiosteal hæmorrhages with proliferation or periosteal elevation is generally observed. As treatment is continued the porosity of bone decreases and new layers of periosteum are noted.

The prognosis is very good. Treatment other than proper splinting consists of supplying vitamin C which is found in oranges, lemons, apples and bananas. As the majority of fractures occur in infants or the very young, practically speaking, the treatment consists of the administration of orange juice in adequate quantities.

Metabolic disturbances—Diabetes Pathological fractures occur among diabetic patients very rarely. It is questionable whether the fracture is a result of the metabolic disease or to associated disease and atrophy.

Metabolic disturbances—hyperparathyroidism. Hyperplasia and also adenomatous changes of the parathyroid glands cause generalized osteoporosis. Pathological fractures may result.

Compere has recently analyzed 12 cases of hyperparathyroidism including one of his own. Five (42 per cent) of these developed fractures. Three (33½ per cent) had had multiple fractures when reported. A recent personal case has had multiple fractures (Fig 19). On three occasions a parathyroid adenoma was removed and the result was pronounced improvement each time as regards health and hypercalcaemia. It is interesting to note that this patient has had many dozens of fractures and has lost exactly 3 feet in stature. Fifty eight per cent of Compere's collected cases were females. The average age was 37 years, the youngest being 7 and 14 years old and the oldest 59 years of age. The majority of them had been diagnosed as osteitis fibrosa. Eight of Compere's collected cases had an adenoma of the parathy-

roid gland. Another was not operated upon but had bilateral palpable tumors (Duken's Case 2). The cases of Boyd, Milgram and Stearns had cystic adenomata. Wilder's cases had undergone malignant degeneration. The personal case proved to have a cystic adenoma of a parathyroid. The blood calcium is increased and chemical studies of the urine and faeces show an excessive output of calcium. In addition to extreme generalized osteoporosis, hypotonicity of muscles and cystic degeneration of bones occur. Deformities are common.

The prognosis in the past has been hopeless but recent operative interference has results in marked improvement. Without operation (parathyroidectomy) the fractures unite slowly and tend to recur.

In addition to immobilization and extirpation of the diseased parathyroid glands, the treatment should be directed toward better calcium deposition. Before operation and after operation the absorption of calcium and phosphorus may be materially benefited by the administration of irradiated ergosterol or codliver oil, heliotherapy, and diet. Future study and literature regarding this interesting subject will eventually clarify the situation.

Fragility due to hereditary disease. Osteogenesis imperfecta (Fig 20) Osteogenesis imperfecta is claimed to be an inherited diathesis of bone fragility as many as 9 individuals being affected in four generations. Multiple fractures occur more often in early life, almost exclusively before the thirtieth year.

Its etiology is little known and its terms are many. The various names confusing this condition are idiopathic osteopsathyrosis, fragilitas ossium, idiopathic fragilitas ossium, brittle bones with blue sclera, brittle bones, congenital rickets, juvenile osteomalacia, osteogenesis imperfecta congenita, osteogenesis imperfecta tarda, osteogenesis imperfecta, hereditary mesenchymic hypoplasia.

Patients suffering with this disease frequently have fractures from trivial traumata or muscular action. Cases are on record where fractures have occurred *in utero* and during passage through the birth canal. The latter should be remembered because of the medicolegal aspects. Usually though multiple fractures take place after birth. The X-ray reveals (except in the postadolescent age) extreme bone porosity and frequently many photographs have to be taken to secure a fair roentgenogram of the pathology. These patients frequently have blue sclera. The long bones of the extremities and the ribs are mainly affected.

In the pre-adolescent stage the fracture lines have a peculiar appearance and they seem to result from a crumpling or bending action, with frequently an attempt to telescope on one surface. This peculiarity is probably due to the fact that the bone is so decalcified as to be actually softened. The bowstring action of the powerful flexor and extensor muscles or torsion is then sufficient to crumple the softened bones. Despite the low calcium content of the bone, fractures heal quickly and with abundant callus. The blood calcium and phosphorus are usually normal or above normal as in hyperparathyroidism.

The immediate prognosis is good but recurrent fractures and premature death often result.

We have had occasion to observe or treat some 8 cases of this condition. In one instance multiple fractures occurred in twins 13 months old. In one family under observation the condition has been present for four generations—a later report will follow.

Osteosclerosis generalisata. Osteosclerosis generalisata has been described by several writers. In this condition all the bones seem to be abnormally hard or sclerotic. It is spoken of as marble bones. The bones are overcalcified (in comparison to osteogenesis imperfecta) and are entirely lacking in elasticity. The fracture line is often very straight (transverse) or steplike and resembles the breaking of limestone or marble. This condition occurs most often in the young. The etiology is not known but it has been considered to be the result of a hypervitaminosis. The X-ray picture is pathognomonic, as the bones are revealed to be extremely opaque.

The immediate prognosis is good. No difficulties are encountered as a rule regarding union, though it may be slightly delayed. The ultimate prognosis is guarded because recurrences are the rule. The tendency to fracture usually disappears after the age of 30 years (Babcock). Merrill has recently reported a case.

Gaucher's splenomegaly. In splenomegaly due to Gaucher's disease (at least) rarefaction of bone takes place. Practically all cases which have recently been subjected to X-ray examinations have shown bone changes. The osteoporosis may be so great as to result in pathological fracture. The lower ends of the femur seem to be oftenest involved.

Welt *et al* have recently reported 6 cases of this disease, 50 per cent of which developed pathological fractures. The patients complain of pains in the bones, stiffness, and limp. The long bones of the lower and upper extremity are chiefly affected. In addition to the splenomegaly the

TABLE IV—PATHOLOGICAL FRACTURES

Pathological condition	Unions	Delayed	Non-Union	Late
Cysts				
Euchondroma				
Osteoma fibrosa cystica				
Myeloma (hemangioma)				
Carcinoma			X	
Sarcoma				
Enchondroma				
Hypertrophism*				
Myeloma (malignant)			X	
Acute osteomyelitis				
Chronic osteomyelitis				
Local pressure			X	
Neuropathic				
Syringomyelia			X	
Polymyositis				
Leukemia			X	
Lactile paralysis			X	
Scurvy				
Bone (proliferative)				
Osteomalacia				
Starvation			X	
Rickets				
Leucy				
Diphtheria				
Hyperparathyroidism				
Osteogenesis imperfecta				
Marble bones				
Gaucher disease				
Phosphorus				
Radiation				
Total	6	26	11	4
Percentage	100	433	182	67

*Scurvy states that union has been known to occur in hyperparathyroidism.

symptoms may resemble osteomyelitis and be operated upon for the same as was the experience of Moschowitz. The diagnosis is made by the blood findings, biopsy puncture and X-ray examination (Fig. 11).

The prognosis is not good. Splenectomy has aided a number of cases in relieving the anemia, hemorrhagic diathesis, and burdensome weight of the organ, but it remains to be determined how curative the procedure is.

Fragility due to chemical irritation in industry. The absorption of certain chemicals in the body may lead to bony deposits of the metal and thence to necrosis. So called "fragilitas osium" among match dipper has been reported by Dearden. According to him, the bones of such workers contain an excess of phosphoric acid which combines with the pre-existing neutral phosphate to form a slightly acid salt and thereby cause excessive brittleness of the bones, i.e., phossy jaw.

Pearl workers' disease is (Da Costa) due to an osteitis from chemical irritation. Tillmans claims that arsenic and pyrogallol acid produce a similar ossifying periosteitis. Pathological fracture due to the destruction of bone by mesothorium has been recorded by Martland. The fracture sustained was of the upper femur in a girl who painted watch dials with luminescent paint.

The treatment consists of eliminating the causative chemical when possible. The prognosis is

generally good as to union, but poor as to complication

ANALYSIS OF UNION IN PATHOLOGICAL FRACTURES

Non union of various grades to excessive union may occur in different types of pathological fracture or in the same disease

The vast majority of pathological fractures unite. Table IV shows that union may occur in 89 per cent of the different diseases and 20 per cent may have excessive callus production

Delayed union (but union nevertheless) may take place in 70 per cent. In only 16 per cent is non union the rule, though Bloodgood is aware of its occurrence in sarcoma hypernephroma and endothelioma. Ten per cent of this latter group are placed in the little known class as insufficient data on reported cases make this necessary. The pseudo fractures described by Milkman¹ probably should be included in the above.

SUMMARY

In fractures through benign tumors union is the rule. In cysts the fracture episode usually results in a cure of the cystic condition

In malignant tumors union often occurs. Hawley states that in carcinoma union is the rule. Bloodgood states that in metastatic carcinoma union rarely takes place. In Pancoast's experience 40 per cent of pathological fractures due to carcinoma unite—with or without irradiation

In sarcoma Bloodgood states that union is almost unheard of. 2 doubtful cases in his report of 22 examples. There has been union in a single case of endothelioma. Pancoast also Pfahler, report no union in their experiences. The patients usually die in bed of their metastases the fracture being incidental. Union is known to have occurred in malignant myeloma cases

Primary bone tumors have an incidence of fracture in 22.7 per cent of cases (Coley and Sharp)

In acute and subacute inflammatory condition union is the general end result, if the infection has early and adequate surgical treatment. In neglected cases especially in adults non union may occur

In chronic inflammatory conditions union is the rule with excessive callus formation

In fractures occurring in general disease, union is delayed or absent depending upon the course of the general disease. In rickets, osteomalacia and scurvy, proper treatment results in union—osteomalacia frequently heals with excessive provisional callus

Eighty nine per cent of causative conditions are known to have union occur, in most of which union is the rule

I take this opportunity to thank Dr H. A. Pancoast and his Department at the University of Pennsylvania Hospital and also Dr Burville Holmes and his Department at the Philadelphia General Hospital for the data furnished by them in the preparation of this article. I wish also to thank Dr Eugene Pendergrass who has so kindly written the X-ray descriptions in the legends.

¹Milkman, L. A. Pseudo fracture. *Am J Roentgenol* 1930, xxiv 29

FRACTURES OF THE PELVIS

A SUMMARY OF TREATMENT AND RESULTS ATTAINED IN ONE HUNDRED AND EIGHTY FIVE CASES

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THREE years ago we reported before the Surgical Section of the American Medical Association a series of 125 fractures of the pelvis, these cases having been treated by us during the period from January 1, 1920 to July 1, 1928.

We now present for your consideration this series together with an additional 60 cases encountered and treated between July 1, 1928 and July 1, 1931, this constituting a total of 185 consecutive cases treated in an 11 year period.

TABLE I—ANATOMICAL DISTRIBUTION

	Left	Right
Ala of ilium	25	12
Superior ramus of pubis	30	24
Inferior ramus of pubis	05	27
Superior ramus of ischium	4	2
Inferior ramus of ischium	31	
Acetabulum	19	18
Separation of symphysis		12
Densate sacro iliac separation		1
Bilateral pelvic fractures		5
Fracture of sacrum with associated fractures of pelvis		10
Fracture of lumbar vertebra with associated fractures of pelvis		12
Isolated fractures of the tuberosity of ischium		1
Double vertical fracture of pelvis (Malgaigne)		6

It will be seen from Table I that very few of the fractures in this series of cases were single.

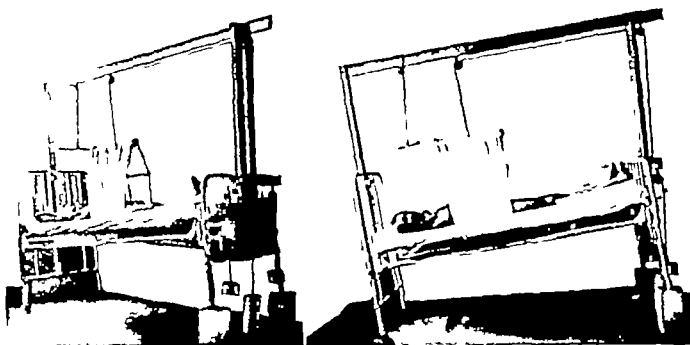
The ages of patients ranged from 2 to 82 years, with a general average of 36 years. The average stay in the hospital was 53 days. There were 141 male patients and 44 females. In 99 cases the fractures were the result of industrial accidents and 86 of civilian accidents. Of the latter 75 per cent were the result of automobile and motorcycle accidents. It is interesting to note that fractures of the pelvis in women during the first three years covered by this series, that is, from 1920 to 1923, constituted only 10 per cent of the total civilian accidents and that since 1923 fractures of the pelvis in women amount to almost 50 per cent of the total civilian cases. Over 70 per cent of these fractures of the pelvis in women were received in automobile accidents, and as far as we are able to judge, such fractures were caused by trauma of definitely less severity than that producing such fractures in men.

It is impossible to divide the severity of the cases in this series with regard to time lost. However in reviewing the civilian and industrial accidents we feel that, while the severity of injury in each type of case was about equal, the civilian cases as a class were worse than the industrial accidents. Seventy-five of the civilians returned to their former duty and the remainder are earning a livelihood at some gainful occupation. The number of days lost from work averaged 142, the industrial accidents losing an average of 154 days, and the civilian accidents returning to work in an average of 130 days. This difference in lost time we attribute largely to the provisions of the Compensation Law.

Sixty-four of the industrial accidents were complicated with other fractures or severe injury of the soft structures. The uncomplicated cases and 24 of the complicated cases returned to full duty without any permanent disability, while the remaining cases had disability ranging from 15 per cent to total disability. In no case was the pelvic fracture the only cause of disability as there were severe associated injuries in every instance. However most of the disabled patients are earning a livelihood today at some lighter occupation.

Complications in these cases, listed in their order of frequency were as follows: blood in urine, extraperitoneal hematomata, extraperitoneal rupture of the bladder, rupture of the deep urethra, intraperitoneal rupture of the bladder, laceration of the perineum, contusion and rupture of the kidney, injury to the rectum, fracture of the femur, dislocation of the hip, fracture of the spine, miscellaneous fractures. In 5 of the total 185 cases blood was found in the urine of these 26 patients had sustained rupture of the bladder, 8 intraperitoneal and 18 extraperitoneal. Eleven patients had either severe laceration or complete division of the deep urethra. In several of the severe cases the apparent tendency to the formation of renal and vesical calculi was very marked during the convalescent period.

There was a total of 30 deaths (16.2 per cent) in the 185 cases. Nineteen of these patients died within 24 hours following admission, all of whom had severe associated injuries which were regarded



Suspension and traction applied in case of fracture of the pelvis.

as necessarily fatal, and the most of them were practically moribund on admission to hospital. The remaining 11 patients died as follows: 3 within 48 hours, 3 within 72 hours, 2 within 3 days, 1 within 4 days, 1 within 32 days, 1 within 4 months. The causes of these deaths varied as follows: shock, pneumonia, rupture of intestines, intra-abdominal hemorrhage, pulmonary embolism, intrapelvic and intra-abdominal hemorrhage, rupture of rectum, rupture of the bladder and urethra, multiple fractures of the pelvis and spine, and general septicemia.

Since the publication of the previous series we have had a number of inquiries from obstetricians as to the effect on normal delivery of various fractures of the pelvis. It so happens that in our series we have observed very few pregnancies subsequent to injury. In one case it was necessary to perform a cesarean section because of impairment of the pelvic outlet. Therapeutic abortion was performed on two patients, one of whom became pregnant $2\frac{1}{4}$ months and one $3\frac{1}{2}$ months after injury. One patient whom we regarded as having only fair results has borne two children since injury. The first delivery which occurred about 2 years after injury was of the breech type; the second delivery $1\frac{1}{2}$ years later, was accomplished by version and extraction. The patient stood both deliveries in a most excellent way. We believe that if pregnancy occurs within 5 months following a severe fracture of the pelvis, therapeutic abortion is indicated. Pregnancies occurring at later dates should be handled as indicated

by the condition of the pelvic ring. In certain cases cesarean section will be indicated; in many others we feel that normal delivery can be accomplished.

Only about 55 per cent of the total series of patients had what we regard as good anatomical position when discharged, but we are sure from our observation, that excellent functional results are frequent in cases in which good anatomical position is by no means secured. Open reduction for correction of displacement of bony fragments was done in only 2 cases, and then only to relieve pressure of the displaced fragment on the rectum and bladder. It is our opinion that what appears to be a poor position of the fragments is by no means a constant cause for persistent pain and disability. We have frequently observed that in cases in which there was marked displacement of fragments there was less pain and less disability than in others in which excellent position was secured. This at times is difficult to explain.

We are still of the opinion that a standardized method of treatment by use of the overhead pelvic suspension frame with traction on the lower extremities presented in our previous paper, will yield excellent results in a higher proportion of cases than any other method.

On admission to hospital complete X-ray examination is made of every patient, and in cases of severe shock this is done by the use of a portable machine at the bedside. Careful and painstaking physical examination is then made to determine as quickly as possible the extent of soft part

injuries. If gross blood is reported in the urine an immediate attempt is made to determine the source whether from urethra bladder or kidney. This, of course calls for considerable judgment and is not always easy as great harm may be done by injudicious instrumentation.

If intraperitoneal rupture of the bladder or other intra-abdominal visceral lesion is suspected laparotomy is performed as soon as the condition of the patient will allow. If extraperitoneal rupture of the bladder is suspected great care is taken in operating to prevent entrance into the peritoneal cavity. If the lesion is in a position to allow of suture, immediate closure is done. If not, very careful drainage both by incision and by catheter is practiced. In cases showing gross lesion of the posterior urethra immediate perineal urethrotomy is performed and whenever possible the urethral lesion is sutured. Drainage should be practiced in every case of gross injury to the bladder with extravasation, but we are definitely of the opinion that hematomata without urinary extravasation should not be drained unless secondary infection should occur. It is unnecessary to say that the treatment of these vesical and urethral injuries should include careful observation for weeks or months after the original injury.

Following careful examination and treatment of complications, the patient is placed in bed and treatment of the fracture begun with an overhead pelvic suspension frame suspension being obtained by a canvas sling or hammock which extends from the upper third of the thighs to the lower dorsal region. This hammock acts as an immobilizing factor because of the lateral compression action on the pelvic girdle the force being approximately equal to the body weight. This force is continually in action and, as relaxation of the muscles takes place, there is a constant tendency for the displaced fragments to fall into their natural position. Generally marked relief of pain is noticeable within the first few hours following the application of the pelvic hammock.

Suspension is supplemented in every case by traction on the legs and thighs, with about 15 to 20 degrees of abduction of the thighs at the hips. Abduction relieves the marked spasm of the strong adductors of the thighs and pelvis, prevents scissoring of the thighs, tends to pull the fragments back into place and prevents the limited abduction that is so commonly observed following these injuries.

The amount of weight on the hammock suspension is regulated by the weight of the body area which the hammock supports. It is our aim to use sufficient weight almost to counterbalance the

weight of the patient, but not enough to raise the patient completely from the bed. Weights used for leg traction vary from 4 to 8 pounds, depending on the size of the patient and the type of the fracture. Cases in which there is involvement of the posterior ring or sacro-fluac dislocation require more weight. It may be necessary to apply more weight on one side than the other depending on the presence of overriding.

Leg traction is used in all types of fracture of the pelvis except in those showing an isolated fracture of the anterior-superior or anterior-inferior spines of the crest of the ilium. In these cases only the hammock suspension is used, supplemented by flexion of the knees obtained by the use of pillows. Flexion in these cases should be about a 20 to 30 degree angle at the hips.

A spreader is used in certain cases to prevent too great a lateral pressure. Lateral pressure of the hammock may at times cause an overlapping at the points of fracture unless it is offset by the intelligent use of the spreader. The degree of lateral pressure can easily be governed by the raising or lowering of the wood spreader. The spreader should be the exact width of the individual's pelvis, within the canvas sling. The use of the spreader should be routine treatment except in cases in which a separation of the symphysis is present. In such cases a high degree of lateral pressure is necessary and is obtained by the use of the hammock without the spreader.

The method of treatment described gives a high degree of ease and comfort to the patient greatly simplifies nursing care, prevents a certain amount of muscular atrophy, allows for improved circulation throughout the pelvis, and provides easy access for care and dressings when the soft parts have been injured. In the simple uncomplicated cases it is rarely necessary to administer an anesthetic in application of the overhead pelvic frame and traction.

We believe that these fractures should be treated by traction and suspension for an average period of at least 42 days. At the end of this time the hammock is removed and the patient is allowed to move about in bed for another week. A pelvic belt is applied immediately after the removal of the hammock. At the end of the seventh or eighth week the patient is allowed out of bed and begins weight bearing with the aid of crutches.

Gradual increase of weight bearing is determined by the amount of callus formation as shown by X-rays and by the comfort of the patient as weight bearing is increased. In certain cases callus formation has definitely been hastened as in-

creased weight bearing is allowed but this method is resorted to only in carefully selected cases.

As convalescence proceeds, daily hot tub baths and local heat are used. Patients are kept under close observation at the orthopedic out clinic until full return to duty is permitted. We feel that a most important point in the securing of results is the keeping of these patients under close observation for a long period.

Judgment should be used in forcing these men back to work. In our early experience we were inclined to return them to work as early as possible but we frequently found that after a few days at work they were inclined to develop muscular

spasm of the back and thighs which necessitated return to bed with consequent lowering of morale. We attempt at all times to assure the patient that he has excellent prospects of recovery and that the long period of treatment in bed is not because of the expectation of a permanent disability but to enable the fractures to be immobilized long enough for union to take place.

We consider that close co-operation between the general surgeon and the orthopedist is necessary in order to secure the best results in these cases, the general surgeon handling complications of the soft parts and the orthopedist that part of the work falling under his jurisdiction.

POSTERIOR MARGINAL FRACTURE OF THE TIBIA

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FROM the year 1768 when Percival Pott gave to medical literature his classical description of that fracture of the ankle which still bears his name down to the present day, fractures of this region have continued to be a surgical problem of ever increasing interest. It is this fact that has given me courage to contribute some observations on the management of one of these fractures, the so-called posterior marginal fracture of the lower articular surface of the tibia. If additional incentive were needed it is the conviction that notwithstanding the wealth of literature available on the treatment of fractures of the ankle, the results generally obtained fall far short of what they should be. This is particularly true of posterior marginal fractures. Testimony to this is borne by the number of poor late results seen when any considerable number of

fractures of the ankle are checked up after the lapse of several years. Of the 15 posterior marginal fractures in this series 5 or 33 1/3 per cent were old fractures with malposition and disability.

Posterior marginal fractures comprise about 19 per cent of all fractures of the ankle joint according to Ashhurst and 10 per cent according to Speed and other writers. In a series of 93 fractures involving the ankle joint seen in our clinic 15 or 16.1 per cent were posterior marginal fractures. The lesion (Fig. 1) is one in which we have a fracture of the internal malleolus with the fracture line extending across the posterior surface of the tibia in such a way as to split off a part or the whole of the posterior margin of the lower articular surface of the tibia and a fracture of the lower end of the fibula, usually low down. The deformity which results is a lateral displacement of the foot and a posterior dislocation of the ankle. Such an injury is in reality a bimalleolar fracture complicated by the splitting off of the posterior part of the lower articular surface of the tibia. It should be mentioned that a posterior marginal fracture may occur without displacement of the ankle (Fig. 2).

The suspicion that a bimalleolar fracture is complicated by a posterior marginal fracture should be aroused by two signs which Cotton has emphasized: (1) prominence of the anterior margin of the tibia which, however, is less as a rule than in complete dislocation of the ankle, (2) the marked instability of the ankle and consequent tendency for deformity to recur after reduction. A properly made roentgenogram



Fig. 1. Posterior marginal fracture showing posterior and lateral displacement of the foot.



Fig. 2, left. Posterior marginal fracture without posterior displacement of the foot.
Fig. 3. The result obtained in case shown in Figure 2



Fig. 4 Posterior marginal fracture. A, Original injury. B, Failure to retain position after reduction and the application of a cast.

should clear up any doubt as to the character of the injury and lead to properly planned treatment. Apparently however, in a surprising number of cases although the bimalleolar fracture is recognized and the deformity corrected, the posterior marginal fracture is overlooked or the importance of completely reducing the posterior displacement of the ankle and accurately restoring the contour of the lower articular surface of the tibia is not appreciated. If this is not done after the fracture heals limitation of ankle flexion and extension remains, a painful ankle results which very definitely interferes with function and a permanent disability is established. In this fracture as in all ankle fractures accurate reduction is essential to a satisfactory functional result clinical evidence all points toward the conclusion that given a good anatomical reduction the functional result is rarely unsatisfactory.

TREATMENT

We have separated the cases of posterior marginal fracture seen in our clinic into three groups.

1. Fractures seen immediately following or within a few hours of the injury
2. Fractures seen after a lapse of several days up to several weeks without reduction.
3. Fractures seen after several months or years with malposition

The fractures seen shortly after the reception of the injury will as a rule, present no particular difficulty in reduction if a correct diagnosis has been made (Fig. 3). Under the general or local anesthesia, the knee should be flexed, to relax the tendo achillis, and the posterior part of the foot strongly adducted and inverted with the ankle in moderate equinus. Since the astragalus and the marginal fragment are attached to the fibula and in fracture of the ankle displaced with



Fig. 5. Posterior marginal fracture reduced by operation and beef bone screw used to hold fragments in place 4 months after reduction.

It seems logical that the primary step in reduction should be the correction of the fibular displacement. When sufficient adduction and inversion have been secured to correct the lateral displacement the foot should be pulled forward and brought into complete dorsal flexion. Dorsal flexion should make the posterior ligament, which is seldom torn, tense and so tend to mold the displaced fragment back into place and hold it there. A plaster cast is immediately applied and for two weeks is allowed to extend above the knee which is held in moderate flexion. Any tension on the tendo achillis should we believe be avoided for this length of time as it may cause a recurrence of the posterior dislocation and displacement of the marginal fragment. After 10



Fig. 8. Old posterior marginal fracture showing characteristic deformity in unreduced case. There is marked impingement of the posterior surface of the tibia against the superior surface of the astragalus.

days to 2 weeks the cast is cut down below the knee and the usual after treatment of fractures of the ankle followed. Weight bearing is not permitted under 8 weeks. The instability of the ankle in posterior marginal fractures should be constantly borne in mind and a checkup roentgenogram made immediately after the application of the cast. We are accustomed to check the position at least once or twice more during the first 10 days or 2 weeks following reduction.

From time to time we have had referred to us cases in which the posterior displacement has not been recognized or in which attempts to secure satisfactory reduction have been unsuccessful and the displacement has existed from several days to several weeks (Fig. 4). In such cases the problem of reduction is somewhat different from that in acute fractures. It is often difficult or

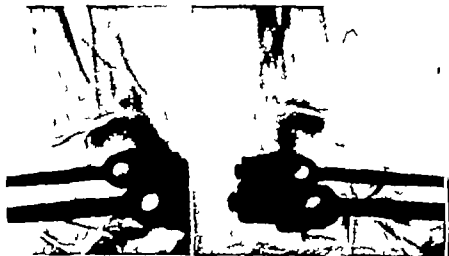


Fig. 6

Fig. 7A

Fig. 6. Posterior marginal fracture with recurrent posterior displacement after reduction showing Kirschner wire through the astragalus.



Fig. 7B

Fig. 7. A. Correction of posterior displacement shown in Figure 6 by skeletal traction. B. Final result in this patient.

impossible to influence the position of the displaced tibial fragment and maintain the anterior position of the foot. The difficulty in reducing the fragment is probably due to organizing procallus filling up of the space between the tibia and the fragment and to adhesions which have formed between the displaced fragment or fragments and the surrounding soft parts. In these older cases, if satisfactory reduction cannot be secured by manipulation, reduction by operation must be resorted to or some form of non-operative management employed which will successfully overcome the displacement. We have operated upon several cases in our clinic in some we have simply reduced the posterior displacement and put the marginal fragment in relation with the tibia. In others in which the fragment was large and the ankle seemed unstable following reduction, we have held the fragment in place with a beef bone screw (Fig 5). The results have been satisfactory if not perfect in all cases operated upon.

We have also used a non-operative type of treatment in these resistant cases which, although not sufficiently tested to allow positive conclusions to be drawn yet seems worthwhile describing. In this non-operative procedure the leg is encased in a plaster cast from above the knee to the ends of the toes, the cast being heavily padded about the lower end of the tibia. The front of the cast is then removed from the ends of the toes to the level of the lower end of the tibia only a posterior shell being left. A Kirschner wire is then passed through the astragalus and, using an overhead pulley direct traction is made upward or in reality forward, on the foot (Fig 6). Counter traction is supplied by the presence of the cast against the lower end of the tibia. Such traction is allowed to remain 3 weeks. In 3 cases in which this method has been used it was found quite efficient (Fig 7). It would seem that this method might be applicable in fresh fractures in which there is a tendency toward displacement after reduction as shown in the roentgenogram. In describing this method of direct skeletal traction, no claim of originality is made as it has probably been used by others in reducing this displacement but has not come to our attention.

In the old fractures with malunion we have, even if posterior displacement has been largely corrected, a filling in of the space between the tibia and the displaced fragment with callus which produces a deepening of the lower articular surface of the tibia from before back (Fig 8). The combination of even slight posterior dis-

placement of the astragalus and deepening of the lower tibial articular surface results in impingement of the lower end of the tibia against the posterior superior surface of the astragalus, limitation of flexion and extension of the ankle, and a painful joint. In dealing with this situation a reconstruction type of operation is necessary and the results in our experience, while satisfactory so far as improvement of function is concerned, still leave much to be desired. Two types of operation have been used in our clinic. In one case, through two lateral incisions an osteotomy of the fibula was performed and the resisting structures around the internal and external malleoli were loosened until the astragalus could be displaced forward. The projecting posterior margin of the tibia was then resected until it ceased to impinge on the superior surface of the astragalus. The result was improved function to a satisfactory extent but still with much disability. In 2 cases the resisting structures were loosened up and the astragalus brought forward as in the preceding case but instead of resecting the posterior margin of the articular surface, a wedge of bone was removed corresponding to the excess callus, so far as we could estimate it, and the normal contour of the lower tibial articular surface restored approximately. The results in these 2 cases were better than in the first case, in our opinion, probably due to the fact that a more normal reconstruction of the lower articular surface of the tibia was secured. In a certain proportion of old cases with extreme deformity arthrodesis of the ankle should be the operation of choice.

CONCLUSIONS

From our experience with posterior marginal fractures, we draw the following conclusions:

1. Posterior marginal fractures of the ankle, if not properly reduced carry the certainty of resulting in marked disability.
2. Immediate reduction of both the lateral and posterior displacement should be carried out and the result checked by roentgenograms every few days for at least 10 days.
3. If adequate reduction cannot be secured by manipulation direct skeletal traction or reduction by operation must be resorted to.
4. Malposition in posterior marginal fractures may be improved by some form of reconstruction operation but impairment of function will remain.
5. If there is any question of the success of a reconstruction type of operation arthrodesis of the ankle should be performed.

COMPOUND FRACTURES OF THE LONG BONES

A REVIEW OF THREE HUNDRED AND FOUR CASES TREATED BY DÉBRIDEMENT CARREL DAKIN TECHNIQUE OPEN REDUCTION AND PLATING WHEN INDICATED¹

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From the Clinic of W. O'Neill Sherman, M.D. F.A.C.S.

DURING the past 15 years in this Clinic, certain definite surgical principles have been routinely adhered to in the treatment of compound fractures and this paper comprises a review of the results of 304 compound fractures of the long bones. These formed part of 7,069 fractures received by employees of the Carnegie Steel Company from 1917 to 1932 and of this number 2,440 34 per cent were compound fractures. This high percentage of compound fractures is indicative of the severe crushing type of trauma causing the injury. The 304 cases reviewed here comprise the compound long bone fractures which came under our care during this period.

These fractures were almost entirely sustained by direct violence and most of them showed extensive mutilation of the soft tissues. They were mainly in men employed in mines, steel mills or railways injured by falls of slate crushed by falling piles of steel or traumatized by coming in forcible contact with moving freight cars.

The majority of these fractures came into the hands of some member of this Clinic within 10 hours of the time the fracture was sustained, about 5 per cent were treated in other hospitals, following the principles outlined here and trans-

ferred under our care as soon as they had recovered from their shock.

The following principles are followed on all compound fractures regardless of their severity.

1 The wound associated with a compound fracture is looked upon as just as stirring an emergency as an acute abdominal condition and at least débridement is carried out with as short a lapse of time as possible. The limb is shaved the skin cleansed with soap ether and alcohol the crushed lifeless flesh is conservatively excised and the wound flushed out with Dakin's solution Vaseline gauze protects the wound margins.

2 Carrel tubes are put in place in the wound and over the wound immediately following the débridement, the limb is elevated and Dakin's solution is used to irrigate the wound sufficiently often to keep it saturated. Usually 2 drams of the solution in each tube are required every 2 hours. The dressing is changed every second day.

3 At the time of operation when the X-ray plates are seen and also the wound itself with its associated bone injury a decision is reached as to the best and safest line of treatment to follow in an effort to obtain as good a reduction of the fracture as possible. Reduction may entail the curetting of the bone ends and approximation of the fragments with immediate application of a Sherman steel plate or screws the application of skeletal traction Kirschner wires adhesive traction with a proper splint or simply support with molded plaster coaptation splints. The treatment decided upon is carried out at the same time as the débridement is done.

4 The wound is left open. It may happen that to apply internal fixation the wound may have to be enlarged and then it is permissible to close the wound for a short distance but any attempt at complete closure is disastrous and unnecessary. In almost all cases the wound will have closed before the bone is sufficiently strong to bear weight and the unfortunate sequence of cellulitis, osteomyelitis, and possibly amputation should be sufficient to deter one from closing a compound fracture when nothing is gained by so doing.

5 The plate or screw if such is applied is removed as soon as union has taken place in the bone unless the wound has already healed over it.



Fig. 1. Case 3 J. P. Showing compound wound of femur on admission.



Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 2 Case 3, J. P. Anteroposterior view of compound fracture on admission.

Fig. 3 Case 3, J. P. Lateral view of fractured femur on admission showing fracture extending down to knee joint.

Fig. 4 Case 3, J. P. Showing anteroposterior view of femur 4½ months after admission.

Fig. 5 Case 3, J. P. Showing lateral view of femur 4½ months after admission.

We cannot stress too emphatically the necessity for an immediate adequate débridement and early institution of Carrel Dakin technique to these wounds. The débridement should consist of removal of all foreign bodies, blood clot tissues thickly impregnated with dirt and dead or dying muscle fascia, skin or periosteum the removal by sharp dissection of the wound edge until a healthy bleeding surface is obtained, the exploration cleansing and free drainage of all cavities. To excise satisfactorily the mutilated tissue in an extensive crushing wound requires a general anesthetic and considerable patience should be

exercised to make sure of leaving the wound absolutely clean. A delayed débridement or one done hurriedly, may lead to infection.

These compound fractures are divided into three classes depending upon the size of the resulting wound and the position of the bone fragments (16, 17). Appropriate well defined treatment is begun within a few minutes of the time of injury by a capable surgeon located at each individual plant. The area around the wound is shaved, cleansed with ether and alcohol, a Dakin dressing is applied and a well fitting splint put in place in an excellent manner and the man is then sent to one of the central hospitals with as short a lapse of time as possible. The man is kept in the hospital until almost complete function has returned so that he may be under our control and guidance and receive the advantages of our physiotherapy department. On discharge from the hospital in most cases he is able to return to light work immediately.

In describing the methods used in the treatment of these three divisions of compound fractures, 5 case reports are included at the end of each division. These were the 5 last cases of each group under our care at Western Pennsylvania Hospital before this data was compiled.

A. In extensive compound, comminuted fractures in which it is impossible to align the fragments satisfactorily and hold them with a steel plate, the wound is cleaned and thoroughly



Fig. 6. Case 3, J. P. Showing compound wound after skin grafting. Thiersch grafts used.

excised as described and skeletal traction, tongs, Kirschner wire or other forms of skin or skeletal traction is applied and the wound is irrigated thoroughly with Dakin's solution. In this class also we shall consider the fractures which though compound are in good position and require only the application of lateral coaptation splints after the débridement has been done.

CASE 1. J. B. 36 years old, injured March 28, 1930, at 4.45 P.M. when pile of steel beams fell on left lower leg almost completely severing the leg. He was treated for shock, a splint was applied and the man was sent to hospital. Examination revealed moderate shock, tremendous destruction of soft tissue and bone. The tibia and fibula were both badly comminuted. Eight hours after accident the wound was thoroughly cleaned under ethylene anesthesia and fragments of bone were put in place between the ends of the tibia. Lateral splints were applied and Carrel-Dakin treatment instituted. On April 17, 1930, it was seen that the comminuted fragments were so small that they would not unite to main fragments and they were removed. The original length of leg was preserved by insertion of Kirschner wires through os calcis and applying traction. On May 23, 1930, wires were removed from os calcis. On June 17, 1930, sequestrectomy of tibia was done. On August 25, 1930, entire healing of soft parts had taken place but there was a 1 1/4 inch separation of fragments of tibia. There had been so much soft tissue destruction that it was felt that more healthy tissue would be necessary over the tibial crest to nourish the bone graft which would have to be put in place. Therefore between September 30, 1930, and October 25, 1930, a large pedicle skin flap was transferred from the right leg to replace the thin scar over the left tibial crest. The man was allowed up on crutches and sent home until time for bone graft. He returned in April, 1931, at which time a sliding bone graft was done with good union resulting. He has good knee motion and fair ankle motion at the present time.

CASE 2. W. G. 30 years old, negro, injured May 7, 1930, at 10:15 P.M. Left leg was crushed between steel beams. Dakin dressing and Thomas splint were applied and he was transferred to the hospital. Examination disclosed a compound, comminuted fracture in upper third of left tibia and fibula, extensive laceration extending over knee joint on outer side of leg, laceration 1 inch in length over inner part of leg. At 1:20 A.M. under spinal anesthesia débridement was carried out. Carrel-Dakin technique was instituted and a Steinmann pin was inserted through the os calcis, and a 15 pound weight was attached, with leg in Thomas splint. June 18 wounds were almost healed so chlorazene ointment was applied instead of Dakin solution. Fibrous union was present lateral splints were applied and patient was encouraged to bear weight from July 1 to July 10, when he was discharged. Returned for physiotherapy until September 9, 1930, when he was sent to work.

CASE 3. J. P. (see X-ray prints and photographs) 45 years old Slav was injured May 15, 1930, at 4:15 A.M. when steel buggy ran over left thigh. The wound was cleansed, a sedative given, a splint was applied at mill and the man was sent to Western Pennsylvania Hospital. Examination revealed considerably shocked but conscious patient. Tissues of left thigh were crushed apart over the lower two-thirds of the thigh, the bone was badly comminuted and displaced. The femoral artery was exposed for 3 inches. At 9 A.M. after treatment for shock patient's thigh was thoroughly cleansed under spinal anesthesia, skeletal traction was applied to the lower end of the femur, a Thomas splint was put in place and 20 Carrel tubes were distributed about the wound. On May 26 temperature had risen to 104 degrees, 15 additional Carrel tubes were inserted and through and through irrigation was established. Temperature dropped to 100 degrees. Pressure pads were used to press the fragments into position. Good union was present and skeletal traction was removed June 17. Active traction was continued until July 10. The

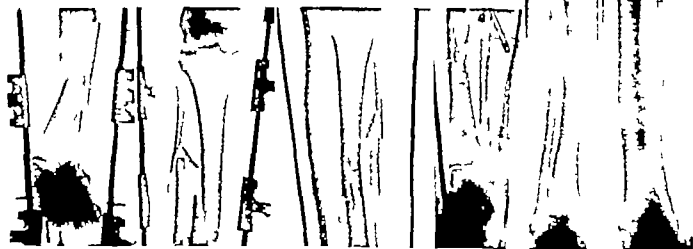


Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 7. Case 6 J. Z. Anteroposterior view of left leg on admission. Compound comminuted fracture of tibia and fibula.

Fig. 8. Case 6 J. Z. Anteroposterior view of right leg on admission. Compound, comminuted fracture of tibia and fibula.

Fig. 9. Case 6 J. Z. Right tibia and fibula. Primary plating done a few hours after the accident.

Fig. 10. Case 6 J. Z. Left tibia and fibula. Primary plating done a few hours after the injury.

Fig. 11. Case 6 J. Z. Showing both bones of both legs, firmly united and with plates removed.



Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 12. Case 9, M. K. Lateral view of compound, comminuted fracture of tibia before reduction.

Fig. 13. Case 9, M. K. Anteroposterior view of fractured tibia and fibula—before reduction.

Fig. 14. Case 9, M. K. Lateral view after primary plating, done 1 day after injury.

Fig. 15. Case 9, M. K. Anteroposterior view after primary plating.

large raw area was macroscopically clean on July 22 and 5 large Thiersch grafts were put in place. The skin was entirely healed by August 5. Treatment was begun with Morton Smart machine. Man was discharged on December 4, 1930, with instructions to return to work immediately. One inch shortening had been compensated by lift on shoe. There was 60 degree motion in knee.

CASE 4. J. T. aged 27 years, steel worker. At 9:30 a.m. on January 21, 1931, a steel "buggy" ran over his right foot and leg. The skin was shaved, cleaned with ether, Dakin's compress was applied, a Cabot splint was put in place at the mill hospital, and the man was sent to Western Pennsylvania Hospital. Examination showed a compound fracture of the right fibula with laceration 2 inches in length just above the ankle joint. There was a simple fracture of the first and second cuneiform bones. All fractures were in good position. At 12 noon on January 21, débridement of the leg was done under novocain 1 per cent, plaster compression splints were applied, and the leg was elevated in Cabot splint. On February 13, the wound was completely healed and physiotherapy was begun with the Morton Smart machine. February 7, no further disability from fractured fibula was noted but there was considerable discomfort from the fracture of the cuneiform bones until his return to work June 7, 1931.

CASE 5. H. C. aged 36 years, bookkeeper injured September 1, 1931, 1:1 a.m. falling down 1 step, receiving a compound, comminuted fracture of left tibia and fibula. He was brought to the hospital immediately. Examination showed a large piece of bone protruding from a wound $3\frac{1}{2}$ inches long on the outer lower third of tibia. X-ray films showed comminuted fracture at junction of lower and middle third of left tibia and fibula and simple fracture of internal and external malleoli. Patient was taken to operating room at 3:15 p.m., débridement of the wound under spinal anesthesia, but it was found im-

possible to reduce the fracture through this wound so an incision was made over the crest of the tibia. The wound was carefully blocked off and tissues and bones handled with non-touch technique. The bone fragments were cleaned with curette and Dakin's solution and jammed between the main fragments, thus preserving the original length of bone. A steel plate could not be applied owing to the comminution present. The operative wound was partially closed while the compound wound was left wide open. Carrel-Dakin technique was begun and the leg was cocooned in lateral plaster splints. On October 10 both wounds were entirely healed. On November 3 treatment with Smart machine was started though only fibrous union was present. Patient could not dorsiflex the foot. On December 1 patient was walking in double leg brace with aid of cane—good union and able to dorsiflex foot slightly. On December 22 he walked quite well with ability to dorsiflex foot 50 per cent and he had full knee motion. He returned to work January 2, 1932. Almost complete return of dorsiflexion of foot present by February and patient working steadily.

B. *Primary plating* (4) When the opening in the skin is at least 15 inches long and the fragments are not in position suitable for good union, a direct attack is made upon the bone immediately the ends curetted and put in good position, a Sherman vanadium steel plate applied, the wound left open and Carrel-Dakin treatment applied. In these cases the screws transfixing the plate to the bone are of such length that they go into the proximal cortex only and except in rare cases, do not go through the medullary canal and transfix



Fig. 16

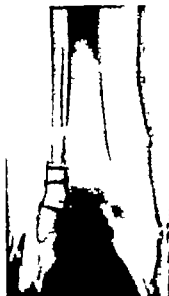


Fig. 17



Fig. 18.

- Fig. 16 Case 10 G G Compound Pott's fracture before reduction
 Fig. 17 Case 10 G G Anteroposterior view of fracture after immediate reduction and application of a plate.
 Fig. 18 Case 10, G C Lateral view of fracture after immediate reduction and application of plate

the other side. When it is necessary to engage a loose fragment on the opposite side of the medullary canal or when a transfixion screw alone is used to hold the fragments of a compound spiral fracture in place then it is quite permissible to send the screw through the canal. Lateral molded plaster splints are applied in such a way that the wound may be dressed without disturbing the supporting splints. The edges of the plaster splints about the open wound are protected with oiled silk to prevent the irrigating fluid from destroying the cast. It is rare that Dakin's solution softens a cast sufficiently in the course of treatment that it is necessary to build a second pair of splints. Dakinization is continued until the wound is only a small abrasion, then chlorazene ointment, zinc oxide or other mild protective is applied until the wound is entirely healed.

CASE 6. J. Z. (see roentgenograms) aged 24 years, was injured April 18, 1928, at 11:30 a.m., by falling 35 feet, alighting on a hard surface. Dressings were applied with Cabot splints at mill hospital and the man was sent to Western Pennsylvania Hospital. Examination showed a moderately shocked man with extensive compound fractures of both bones of both legs, simple fracture of both os calcis and dislocation of left ankle. On April 18, at 5:00 p.m., after treatment for shock, both legs were thoroughly cleaned of mutilated tissue under ethylene anesthesia and four screw Sherman plates were applied to each tibia. The wounds were left open and Carrel-Dakin treatment was instituted. The dislocation of the left ankle was reduced. On June 16, 1928, both plates were removed and the screw holes curetted. On August 20, 1928 firm union was present and patient was walking

with double leg irons. On March 21, 1929, both legs were entirely healed and patient was discharged to light work. Patient left work and returned on February 2, 1930, when a pedicle flap was put in place over the crest of the left tibia. It was later necessary to fuse both os calcis astragaloid joints. There is still some pain present in left os calcis-astragaloid joint.

CASE 7. M. B. aged 35 years. On March 11, 1930 at 7:30 a.m. patient's right forearm was caught between a crank arm and beam. The wound was cleaned, splint applied and he was sent to hospital immediately. Examination revealed a compound, comminuted fracture of the right radius with considerable displacement, a simple fracture of the right ulna with angulation. The wound was debrided at 11:35 a.m. under ethylene anesthesia, the ulnar angulation straightened and the fractures of the radius placed in good position and held by one screw. Anteroposterior plaster splints were applied and Carrel-Dakin treatment was instituted. On April 29, 1930, good union was in both bones. The wound healed and Morton Smart treatment was begun. Patient was discharged to light work on May 13, 1930 with full motion present in wrist and elbow.

CASE 8. P. P., aged 60 years. May 17, 1930 was struck on the left leg by a flying piece of machinery as the result of an explosion. Two open wounds over the left tibia were cleaned, Cabot splint was applied at the mill hospital and man sent to city hospital. Examination showed compound fractures of the left tibia and fibula at junction of the upper and middle thirds and at the junction of the middle and lower thirds. Each compound wound was about the size of a 50 cent piece. The lower fracture of the tibia was comminuted. Man was in moderate shock. Under ether anesthesia, 4 hours after the accident, débridement of the wounds was done and a four screw Sherman plate was applied to the upper fragments and two transfixion screws held the lower fragments in excellent position. Lateral plaster splints were applied and Carrel-Dakin technique commenced, with leg elevated in a Cabot



Fig. 10. left Case 14, B C. Showing lateral view of compound fracture of tibia before secondary plating was done.

Fig. 20. Case 4, B C. Secondary plating done 14 days after injury. Two attempts at closed reduction had failed. Plate healed in 48.

spint. Man collapsed during the operation and artificial respiration and intravenous adrenalin were resorted to before he revived. On June 9, 1930, plaster spints were changed and the upper plate was removed. On July 5, 1930, screws in lower fracture were removed and screw holes carried. Good union was present in both fractures. On July 8, 1930, the compound fracture wound was entirely healed and a Delbet spint was applied. Treatment with Morton Smart machine was commenced. On August 1, 1930, a walking Delbet spint was applied. On September 5, 1930, patient was discharged wearing only a single leg iron with firm union in fractures and 80 per cent motion in knee and ankle.

CASE 9. M. E. (see roentgenograms) injured June 16, 1931 at 3:30 p.m., when he fell a distance of 15 feet, receiving a compound, comminuted fracture of the left tibia and fibula. The wound was cleaned with ether, a Dakin's compress was applied and a Thomas spint put in place at the mill hospital, and the man sent to Western Pennsylvania Hospital. Examination disclosed a 27 year old steel worker in slight shock. A fragment of the tibia was sticking through an open wound $5\frac{1}{2}$ inches in length in the lower third of the left leg. At 5:00 p.m., June 16, a débridement was done under spinal anesthesia. The comminuted fragments were replaced after cleansing with a curette. A six screw Sherman vanadium steel plate was applied, the wound was left open, and the Carrel-Dakin technique was instituted. Lateral plaster spints were applied and the leg was elevated in a Cabot spint. After the second day temperature never rose to one hundred degrees. Carrel-Dakin treatment was continued until the leg was entirely healed on August 26, 1931. Physiotherapy in the form of Morton Smart treatment was begun and by September 15, 1931, firm union had taken place in the tibia. Man was given treatment for erythema. Discharged to work on November 4, 1931 with the plate still in place.

CASE 10. G. G. On December 20, 1931, this 25 year old man fell 60 feet, injuring the whole of his right side. He was brought to the hospital immediately. Examination disclosed a compound fracture of the lower third of the right tibia and fibula with complete lateral dislocation of the ankle. The foot was blue and discolored. Patient was in shock. He was given a large intravenous injection of saline with adrenalin. Then 4 hours after the accident, a complete débridement and replacement of the dislocated bone was done under spinal anesthesia. A 3 screw Sherman plate was applied to the fibula and Carrel-Dakin treatment was started with leg in plaster spints and elevated in a Cabot spint. Temperature never went above 100 degrees. Complete circulation returned in foot. On January 20, 1932, union was present, and plate was removed. On February 5, 1932, wound was almost entirely healed and patient was walking. He was to be discharged in 14 days.

C. Secondary Plating (6) When the open wound is the size of a 50 cent piece or less and it has been decided that the fracture could be more accurately replaced by a direct attack and application of a plate than by extension, then débridement of the wound is carried out under local anesthetic, Carrel-Dakin technique is instituted, and an open reduction done later. Novocain, 1 per cent, is injected into the skin margins of the wound and proves to be sufficient anesthetic to allow a thorough débridement of such a small wound. The dangers of stirring up an infection by the injection of the novocain is negligible when it is done within the first 8 hours after the injury. This secondary plating may be done from 10 to 15 days after the injury, the time being decided by the temperature which must have been normal for 2 or 3 days, and by the condition of the open wound, which must have either healed or be microscopically clean. The limb must have returned to almost normal size the bruise have healed, and the edema and ecchymoses subsided. The plate is not applied through the open wound, but a fresh incision is made, away from the wound, the skin margins carefully blocked the plate applied with non-touch technique and the skin closed over it. In other words, it is treated as a simple fracture. In this series, 71 cases were secondarily plated and in 48 per cent, it was unnecessary to later remove the plate.

CASE 11. M. B., aged 23 years, was injured November 12, 1931, by being struck on left leg with a chain. He was admitted to Youngtown Hospital where it was found that he had a compound, oblique fracture of tibia and fibula 4 inches above the left ankle. Débridement was carried out and position of bones improved by a closed reduction. Carrel-Dakin treatment was carried out on the two compound wounds. Owing to the fact that there was $3\frac{1}{2}$ inch shortening in tibia, man was sent to Western Pennsylvania Hospital on December 7, 1931. Examination revealed two healthy compound wounds on lower part of left leg. Temperature was normal. On day after admission an open reduction was done and 4 screw Sherman plate was applied to tibia and operation wound was closed. Carrel-Dakin treatment was continued to the

compound wounds until healing took place January 2, 1929. Patient made an uneventful convalescence except for a general dermatitis of whole body due to a sensitivity to picric acid which had been used in preparing his leg. February 12, 1929, patient was walking with brace applied to leg; good union. March 19, 1929, he was discharged with 80 degrees knee motion and plate still in place.

CASE 12 G. G. aged 23 years, was injured January 30, 1929, by being crushed between battery machine and oven door. The right thigh was bleeding profusely from two puncture wounds. These were cleaned, packed with Dakin's gauze, Thomas splint applied, and the man was transferred to Western Pennsylvania Hospital. Examination showed the whole thigh crushed puncture wounds on anterior and posterior part of right thigh. The distal fragment of femur was displaced backward with $3\frac{1}{2}$ inches overriding. A Thomas splint with Buck's extension was applied after immediate débridement of both wounds, under novocain 1 per cent. Carrel-Dakin treatment was applied to the two compound wounds. On February 12, 1929, temperature had been normal for 2 days, and as closed reduction was not satisfactory under spinal anesthesia an open reduction of the femur was done away from the compound fracture wounds. A 6 screw Sherman plate was applied and the wound was closed. The leg was put up in Thomas splint in 45 degrees flexion. There was no postoperative temperature rise. On February 17, 1929, knee motion was commenced by patient elevating and lowering the Pierson attachment to Thomas splint through 45 degrees. Hairline reduction of fragments was shown by X-ray film. On April 17, 1929, firm union was noted and both wounds were closed. The Sherman plate had not been properly tempered and broke at the site of fracture. On May 1, 1929, patient was walking with caliper splint. On May 21, 1929, the broken plate was removed and the wound was closed tightly. On July 20, 1929, the patient was discharged to light work with 85 degrees motion in knee.

CASE 13 L. T., aged 35 years, was injured January 14, 1929, by slipping into a ditch. He received a wound on the left lower leg which was cleaned, a splint was applied at the mill and the man was sent to Western Pennsylvania Hospital. Examination disclosed a compound, comminuted fracture of the lower third of the left tibia with a wound the size of a 10 cent piece. The bones were not in contact. The leg was placed in Cabot splint after a débridement was done under novocain, 1 per cent, on admission. On January 25, 1929, when swelling had subsided and temperature had been normal for 3 days, an open reduction was done at a point away from the wound. A 4 screw Sherman vanadium steel plate was applied. The leg was put up in lateral coaptation splints, Carrel-Dakin treatment was carried out on the open wound, with the leg elevated in a Cabot splint. On March 12, 1929, he was receiving physiotherapy, and firm union present. Operative wound had healed by primary intention and original wound healed 2 weeks after operation. On March 21, 1929, he was walking in a leg brace. On March 26, 1929, he was discharged and on April 18, 1929, he returned to work.

CASE 14 B. C. aged 27 years. On April 30, 1931, at 7 a.m. patient was crushed by a steel "buggy" receiving multiple injuries to the left leg. His wounds were cleaned and a Thomas splint was applied at the mill emergency hospital. The man was then transferred to the Western Pennsylvania Hospital. Examination revealed a $2\frac{1}{2}$ inch laceration on the inner side of the left thigh the tissues were crushed and torn in the left popliteal space. The middle third of the left tibia showed a compound wound the size of a 25 cent piece on the lateral surface. The distal



Fig. 21 Photograph of compound comminuted fracture of tibia, showing an extensive wound partially closed. Sherman plate in place. lateral plaster splints applied in such a way that the wound could be dressed without removing the splint. Carrel tubes which entered every part of the wound are not shown.

fragment was displaced backward and there was no contact of surfaces. Kahn reaction 4+. At 12 noon on April 30, under spinal anesthesia débridement of the lacerations and wound was done and the laceration about the knee was closed. The fractured bone ends were replaced as accurately as possible and Carrel-Dakin treatment commenced on the open wound. On May 7, 1931, another attempt was made at closed reduction but check X-ray pictures showed that a sufficiently accurate reduction had not been obtained. On May 14, 1931, temperature was normal for 2 days and an open reduction was done with non touch technique about $1\frac{1}{2}$ inches away from the compound wound and the operative wound was closed tightly over the 4 screw plate. Carrel-Dakin treatment was continued to open wound and to crushed area in popliteal space. There was no rise in temperature after operation. On June 30, 1931, good union was found with plate in place. The wound healed. Thiersch grafts were put in place over the microscopically clean area in the popliteal space. On July 10, 1931, active motion with treatment by Morton Smart machine was begun. On August 27, 1931, the man was walking without a leg brace or cane and was discharged to work on October 2, 1931.

CASE 15 W. F. aged 43 years, was injured August 31, 1931, when a steel beam fell on his right leg; at mill hospital wound was cleaned gauze saturated with Dakin's was applied to the wound and a Cabot splint applied. Examination revealed a compound comminuted fracture of the lower half of the right tibia and fibula with fragments in poor position. The wound was thoroughly excised and cleansed under novocain 1 per cent and Carrel-Dakin technique was begun 3 hours after injury. On September 10 after temperature had been normal for 3 days and ecchymosis had subsided an open reduction was done at a part away from the compound fracture wound. A 4 screw Sherman steel plate was applied and the operative incision was closed. On November 5, 1931, firm union was present. Treatment was begun with the Morton Smart machine. The compound fracture wound healed. The man was greatly troubled with psoriasis. On November 20, 1931, the man was walking well, with a leg brace applied and 75 per cent motion was noted in the knee and ankle. December 29, 1931, for the past week there has been a slight serous discharge from the operative wound and since it was necessary to remove some hamorrhoids, it was decided also to remove the plate. This was done and the screw holes were curetted. Carrel-Dakin treatment was instituted, and the wound was completely closed, with free motion in knee and ankle on discharge from hospital on January 29, 1932.

Armamentarium (14) To obtain good results in reducing and plating fractures, one must treat the

soft tissues and bones with great respect other wise the contused tissues will more readily succumb to infection. Much can be accomplished by having the proper equipment with which readily and easily to reduce these fractures, with the minimum of trauma. To accomplish this one should have available Lane bone holding forceps, Lambotte bone and plate-holding forceps, Lowman bone clamps, bone skids, Smith-Petersen forceps, Berg forceps, Stille Sherman bone drill, and a wide variety of Sherman vanadium steel plates and screws. In certain instances, a Berg bone traction clamp is an essential instrument, as with it a fracture very difficult to reduce, is slipped into place easily and without trauma. A well prepared and stable (12-13) Dakin's solution is the most important single item in the whole armamentarium of the treatment of compound fractures. The solution used in the treatment of these cases and referred to above as Dakin's solution is a 0.45 to 0.5 per cent sodium hypochlorite in hypertonic saline, this being a non-toxic, non-caustic, and non-irritating solution which has a high bactericidal power. In addition the solvent properties demonstrated by this fluid its ability to dissolve and wash away necrotic tissue, old blood etc. aids materially in cleaning the wound. A commercial product by the trade name of "Hyclorite," the active ingredient of which is sodium hypochlorite 4.05 per cent, is the solution used in this clinic for the making of Dakin's solution. Seven parts of sterile water are mixed with one part of Hyclorite to obtain the proper solution. This is made up daily and titration is unnecessary. If the solution is too caustic it is possible that it might absorb fresh callus, forming in fractures and Clay Murray (11) asserts that this has happened in some cases of compound fractures under his care, but certainly in this large series there has been no retardation of the formation of callus due to the irrigating fluid.

The dangers of non-union, osteomyelitis, cellulitis, and septicemia have been stressed by many writers when any observations are made regarding the advisability of openly reducing and plating compound fractures. In the early days of the war the British Army applied many steel plates in treating compound fractures, and it was later necessary to prohibit such practice. The reason for the untoward results leading to the abolition of the plates was that debridement was not carried out, nor was the Carrel-Dakin technique for the treatment of wounds known. Without the benefits of debridement or the knowledge

of the Carrel-Dakin technique, similar results would have been obtained in these cases, but it is the combination of these two procedures that eradicates the great danger in compound fractures—infection. Many writers both in the United States and abroad have based their judgment on the open reduction or plating of compound fractures on the results obtained during the early days of the war and not on the results obtained through the application of knowledge later developed. A Sherman vanadium steel plate or screw was applied in this series of cases when it was felt that such would give more accurate apposition of the fragments than could be secured in any other way. No hesitancy (10) was felt in applying a plate to the bone but rather a feeling of security knowing that the chance of the bone becoming displaced was reduced to a minimum and that the more accurate the contact of the fragments, the less the chance of non-union. There were no instances of septicemia, no cases of frank osteomyelitis, and no deaths due to infection in this series. Two patients only of the entire series died: 1 from pneumonia 5 weeks following an open reduction of a fractured tibia, the other from shock following a bone graft of the radius, 6 months after his original injury. In but 1 case an amputation was done on a tibia, plated 5 weeks previously. This was necessary due to the extensive trauma of the soft parts and blood vessels, with massive destruction of the bone, and not due to any infection. In many clinics the amputation would have been done immediately and, as it later proved, this was the procedure which should have been carried out. *The other three hundred and one cases returned to work in the mills, mines and railroads with good function.*

Incidence of chronic osteitis. In this series, if a discharging sinus was still present at the site of fractures or operation 4 months after injury it was assumed that chronic osteitis was present. This frequently consisted of only a small sequestrum and the sinus cleaned up rapidly after a sequestrectomy was done and the diseased bone was removed.

There were 22 cases of chronic osteitis in 150 cases of compound fractures which were subjected to debridement on admission, kept clean with Dakin's solution, and treated by traction or splinting. Seventeen patients developed chronic osteitis in 154 cases which had been openly reduced and in 129 of which a plate had been applied (Table I).

Briefly there was a discharging sinus present 4 months after injury in 11.6 per cent of the plated

TABLE I.—CHRONIC OSTEITIS IN COMPOUND FRACTURES

	Cases	Osteitis	Per cent
Openly reduced and plated			
Primary plating	58	9	15.5
Secondary plating	71	6	8.4
Combined per cent			11.6
Openly reduced			
Not plated	25	2	8.0
Not openly reduced			
Traction	53	10	19.2
Splinting	89	12	13.3
Combined per cent			15.7

cases and in 15.7 per cent of the cases treated by traction or splinting. These all eventually healed.

Incidence of non union. Non union was assumed to be present in this series, if the fractured bone was not firmly united 6 months following the injury (Table II).

In these 9 cases of non union only one case had any evidence of syphilis and as 14 per cent of these injured men do have a positive Wassermann it is felt that syphilis played no part in the failure of the bones to unite. All of these non unions were treated by bone grafts with subsequent union except the man who died of shock on the day of his operation.

To be absolutely fair, one must point out that the most severely comminuted fractures could not be plated and this fact probably raised the percentage of chronic osteitis and non union in the unplated fractures, owing to the fact that these two conditions more often develop in badly comminuted compound fractures.

Removal of plates. It has been our custom to remove the steel plates from compound fractures as soon as union has occurred. If however, the wound heals with the plate in place and it is not troubling the patient the plate is not removed. In this series of 58 primary platings, the plate was left *in situ* in 7 cases (12 per cent). In 71 cases of secondary platings, the plate was left in place in 34 patients (48 per cent). In simple fractures in our hospital the plate is rarely removed but remains untouched in at least 95 per cent of the cases.

In a review of these hospital records for this 15 year period (1917-1932) certain gradual changes were noticed in the method of treating compound fractures. One of the most noticeable was the fact that traction with moleskin adhesive has largely been supplanted by the surer traction of tongs or wires. This is especially true in compound fractures in which the irrigating fluid serves to loosen the adhesive too frequently. The length of complete immobility has also been greatly short-

TABLE II.—NON UNION IN COMPOUND FRACTURES

	Non-union Cases	Combined Per cent
Openly reduced and plated		
Primary plating	58	1
Secondary plating	71	1
Unplated fractures		
Opened	25	
Traction	53	3
Splinting	98	4

ened and active motion and graduated muscular exercise with the Morton Smart (15) machine, is begun even before there is X ray evidence of callus and when manipulation shows only a fibrous union to be present.

Diathermy has been dropped as a means of stimulating fracture union, whereas, 8 years ago it was felt to be essential to rapid repair.

In this series the open wound of the compound fracture was so extensive that 24 of the cases had full thickness skin grafts put in place to close the wound with the minimum of scar especially when the scar was over the tibial crest, where the blood supply is poor and ulceration is prone to develop. In extensively scarred wounds over ununited bones pedicle skin flaps were routinely put in place before grafting in order that the increased blood supply of the surrounding tissues would more certainly nourish the graft.

Any attempt at a review of the literature (1, 3, 5, 7, 9) written on this subject during the past 10 years would be foolish in the extreme as a wide variety of men working under diverse conditions advocate many different methods of management. The trend in the past few years has undoubtedly been toward the more accurate apposition obtained by openly reducing these compound fractures when necessary. This, combined with the Carrel Dakin method of wound sterilization, not as a treatment after infection has set in but as a prophylaxis as soon as the injury is incurred gives the surest and safest method of handling compound fractures.

Dr W. O'Neill Sherman organized and supervised the method of treatment of almost all of these patients, and it is with his gracious permission that I am reporting these cases. To Dr Sherman and to Dr J. Huber Wagner, who also operated on many of these cases, I wish to express my sincere thanks.

SUMMARY

1. A series of 304 cases of compound fractures of the long bones of which 129 were openly reduced and plated.

2. The Carrel-Dakin technique was used in all cases to keep the wound clean and healthy and in addition accurately to appose the fragments an open reduction and plating was done when necessary.

3. The percentage of cases of non-union and chronic osteitis in the unplated fractures was greater than in the fractures which had been plated.

4. This series shows that the accurate open reduction and plating of a compound fracture in addition to the use of the Carrel-Dakin method of wound sterilization to the wide open wound tends toward rapid union without infection, rather than toward infection non-union septicæmia, amputation or death.

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CONFERENCE ON TRAUMATIC SURGERY

INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FRANKLIN H. MARTIN M.D., F.A.C.S. CHICAGO

Director General, American College of Surgeons

THE Board on Industrial Medicine and Traumatic Surgery had its genesis during the Great War. Traditions and theories were ruthlessly cast aside. It was necessary to execute tasks expeditiously and efficiently, and with the greatest economy of management, money, and man power. It was advantageous to the government to develop every facility that would preserve health. Hence a committee on industrial medicine was organized by the Medical Section of the Council of National Defense.

In a word, this program demonstrated as never before that the employer and the employee could accomplish most if they worked harmoniously. The great leaders of industry of labor and of insurance composed their differences, to the great benefit of all concerned. This war experience was a progenitor of the Board under whose auspices this conference is being held.

In 1922, Dr. Daniel Z. Dunott convinced the Association of Railway Executives that railway employees would receive the most efficient care in hospitals approved by the American College of Surgeons. Forthwith by proclamation to the railroads, this association suggested that the em-

ployees of railroads so far as possible and practicable, should be treated in approved hospitals.

At the organization meeting of this Board held during the Montreal Clinical Congress in 1926, an important first principle was recognized. The leaders of industry, of labor, of the insurance and indemnity companies, and of compensation commissions must harmonize their interests. And it is an outstanding slogan of the College that if we can convince the heads of these groups we will be insured of the full unqualified co-operation of assistants and associates. This principle is sympathetically endorsed by your chairman, Dr. Blesley.

The real work is already under way. We have held our conferences each year, and by correspondence we are in touch with everyone interested in the progressive work of this Board. During the past year two medical men have secured first hand information from the four groups with whom we must deal.

Up to this time we have been a fact finding organization. It is our purpose to plan for the future. And we must all co-operate if we are to be of aid and if we are to solve the problems of industrial medicine and traumatic surgery.

SUMMARY OF A SURVEY OF MEDICAL AND SURGICAL SERVICE IN INDUSTRY IN NORTHWESTERN UNITED STATES

E. W. WILLIAMSON M.D. CHICAGO

THIS report is based on a survey of 375 industries of various types in the central and eastern sections of the United States, the majority of which maintain a payroll of five hundred or more employees. Approximately three quarters of a million people are employed in these 375 industries, 178 companies (47 per cent) carry their own compensation insurance, 166 (44 per cent) are insured by indemnity companies, 31 (9 per cent) operate under the state fund or have

rejected the compensation act and are subject to the common law.

The following summary is based on the application of the Minimum Standard for Industrial Medicine and Traumatic Surgery as formulated by the College.

1. *Medical staff* Industries have evolved various plans for the care of injuries incurred during employment of the 375 industries reported, 58 plants engage one or more full time physicians

and maintain complete dispensary facilities 156 have part time physicians and operate a first aid room for the care of injuries and minor illness, while 161 have physicians only on call with limited or no facilities in the plant for medical care.

Plants which employ full time or at least half time physicians receive the benefits of active medical supervision and a more extended medical service, such as pre-employment and periodic physical examinations, diagnosis, and a service in preventive medicine. The physician is entrusted with the administration of the department.

Where the industry relies upon the services of a physician who is on call only there is little or no medical supervision. The reduction of employment this year has changed the status of many physicians from a part time to a call basis and under such conditions the nurse must assume more responsibility in providing relief and in deciding which cases should be sent to the physician for treatment. Injuries referred to a physician are usually treated in his office, so the plant operates for long periods of time without a visit by the physician. He is out of touch with the personnel and his only interest and responsibility lies in the care of the occasional patient who is referred to him. This type of organization of the medical service is too remote to be efficient.

2. *Membership on the medical staff* The requirements for membership on the medical staff, as stated in paragraph 2 of the Minimum Standard for Industrial Medicine and Traumatic Surgery are fulfilled by the appointed physicians in almost all the industries visited. In two plants where no medical director is employed, the condition had arisen that non-medical practitioners were authorized to treat compensation cases outside the plant dispensary.

3. *Clinical records* Many industries have a well organized and complete record system. It was found, however that in dispensaries of a large number of industries which employ an indemnity company to carry the compensation insurance the clinical records consist only of reports of cases treated in the dispensary. The employer is wholly dependent upon the carrier for the reports of cases treated in the surgeon's office or hospital. These records may be needed for reference in years to come perhaps after a change in insurance companies has been made therefore, records of all cases should be filed in the office or dispensary of the industry.

4. *Hospitals* Where the operations of the industries are centralized one or more leading hospitals located conveniently to the plant are designated for the care of accident cases. This type of

industry uses only a small number of hospitals and the most of these are on the approved list of the College.

Companies which have a decentralized personnel, such as public utilities, usually specify that the injured employee be taken to the nearest hospital. The result of this arrangement is that a large number of institutions is used and the choice is made on the basis of proximity to the scene of accident rather than upon the rating of the hospital.

Aside from location, the selection of non-approved hospitals may be made by the employee who is not informed, by the physician who does not discriminate or by the one who pays the expenses because the rates may be lower. Industries should know more about the merits of an approved hospital and the reasons for the statement in the Minimum Standard that all patients requiring hospitalization shall be sent to approved institutions.

5. *Medical supervision* Only the larger industries with physicians on a part time or full time basis have arranged for medical supervision of plant sanitation and health of employees. Plants which have the hazards of occupational disease are the most active in carrying out rigid measures in sanitary inspection and periodic examinations of employees who are exposed to these hazards.

There are problems arising in connection with the handling and settlement of occupational diseases which authorities state are much more difficult to solve than adjustment of compensable injuries. Many companies, especially the larger ones, which have operated under direction of the compensation law for 20 years, have carried on effective programs in the prevention of accidents and the care of injuries to the extent that loss of time and compensation therefore have been reduced extensively. Within some of these companies there are certain occupational diseases, such as silicosis, which are creating new and difficult situations. The affected trades are looking to the medical profession for assistance and a solution of these problems.

6. *Scope of medical service* Only a small percentage of industries included in this survey extend medical treatment beyond the care of injuries and emergent and minor illness arising during working hours.

Of the 375 plants visited 330 maintained a dispensary with facilities sufficient to supply the specified service. The results of our studies show further that 241 (64.3 per cent) of the industries provide pre-employment physical examinations, while 115 (30.6 per cent) have periodic examina-

tions of all or certain groups of workers, 290 companies (77.3 per cent) have some form of benefit plan in operation, such as (1) a mutual aid association maintained by the employees alone or on a contributory basis. The benefits are weekly cash allowances for a stated period payable for loss of time due to illness and non-compensable

injuries. Only a small percentage of these associations provide the doctor's services. (2) A relief plan maintained by the company. (3) A group insurance plan which provides benefits for total disability and death, and in a small number of cases an allowance is provided also for illness and non-industrial injuries.

1932 SURVEYS OF MEDICAL SERVICE IN INDUSTRY

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DURING the past year surveys have been made of the medical departments or services of varied industries at selected points in most of the United States. The purpose of these surveys, as directed by the Board on Industrial Medicine and Traumatic Surgery is to get the facts in regard to such medical service, to advance the efficiency of the service and to promote a better working co-operation between industry and the medical profession.

The surveys included 246 industries, representing a total of one million sixty two thousand employees or an average of four thousand employees each. Thirty-six per cent of the total employees involved had payroll deductions to provide complete medical and hospital service on some contract arrangement and in 6 per cent the families were included in this service. Seventy-five per cent of the industries visited had physicians either on a part time or full time basis and 70 per cent gave pre-employment physical examinations. Further organization for the provision of medical service appears to be inevitable. If the 36 per cent of employees mentioned wish to be served medically on some group insurance basis, would it not be possible and advisable to link up the doctor in some form of harmonious participation but still retain his identity and private status?

The plans and facilities for medical service ranged from no facilities or organized service whatsoever in the smaller industries to well equipped dispensaries and competent medical staffs in the larger or more hazardous industries. Most of the larger industries should be given credit and recognition for adequate care of their industrially ill and injured employees. To the smaller industries whose medical service is less efficient the efforts of the College in industrial medicine and surgery should be directed.

Contract medical practice which originated in isolated industrial communities has received considerable impetus under the stress of the present prolonged economic depression. The following

conclusions in regard to contract practice are based upon observation and upon direct information from those who are involved in the practice.

Among the good points may be mentioned

- 1 The Group Insurance principle is utilized to provide medical care at low cost
- 2 It gives the employee and the employer a sense of security
- 3 Experience in this restricted field makes those that practice it more efficient.
4. Special facilities and full time service for the care of ill or injured are usually provided.
- 5 It fixes responsibility which is naturally considered an advantage by the employer
- 6 Uniform and prompt reports are rendered to the industry and to the State Compensation Department

7 It is a plan that can compete with the present day method of installment buying

Among the weak points and abuses are

- 1 Solicitation. In practically every instance there has been more or less solicitation either by the doctors or by paid lay solicitors.
- 2 Price cutting and bribery resulting in typical price wars.
- 3 It denies a reasonable latitude of choice of doctors or hospitals.
4. It permits the extremes of inferior medical and hospital services.
- 5 Unfair competition with the independent practitioner
- 6 Unreasonable demands made of the doctors.
- 7 Commercial exploitation of the profession. Commercial and other lay corporations are found practicing medicine

8 Medical and hospital service under contract practice is not always restricted to the low wage earner

It would seem that contract practice has its good points but inasmuch as it is subjected to so many abuses no blanket endorsement can be made of this type of practice. Each case must be judged upon its own merit.

INJURIES TO THE LUNG

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IT was a great tragedy far beyond the imagination of any except medical officers with long service in advanced operating centers that not until the summer of 1916, after 2 years of intense fighting, were the possibilities of more radical intrathoracic surgical interference appreciated. In those 2 years thousands of lives were sacrificed that could have been saved if thoracic surgery had advanced as had surgery of other parts of the body. The success of that great master surgeon John B. Murphy and Sir William MacEwen in dealing with intrathoracic disease under ordinary general anesthesia was entirely overlooked. The effort of Sauerbruch and his followers with the negative pressure chamber although it contributed somewhat to the advance in surgical technique of intrathoracic problems, served mainly to cloud the issue and render more absurd our knowledge of the physics of the chest and increased the temerity of surgeons in dealing radically with intrathoracic conditions.

For 2 years of war we had watched hundreds of young men, the flower of the manhood of the nations die of chest wounds. Certain types of gunshot wounds of the chest were considered "necessarily fatal" and practically one hundred per cent of patients with such wounds died within 1 hour to 48 hours of being wounded. Approximately 78 per cent of all patients with thoracic wounds died. Largely as a result of the work of one surgeon in the French Army and two surgeons in the British Army—in the summer of 1916 and almost simultaneously although working separately the safety of radical intrathoracic surgery was determined and the mortality even in the so-called one hundred per cent "necessarily fatal" cases was reduced to 37 per cent. The vast number of such wounds dealt with during the last 2 years of the war firmly established the fact that the thorax could be widely opened, its contents be freely handled and dealt with, with less risk than in the routine abdominal procedures.

In addition, the convalescence was more rapid and complete and soldiers could be returned to their units for duty earlier than was the case in gunshot wounds of the abdomen, head, or extremities. This was no small consideration where man power was being so constantly and rapidly destroyed. Let us forget, may I point out that during the months of July August and Septem-

ber, 1916 sixty two thousand stretcher cases, entirely apart from walking-wounded, passed through our Casualty Clearing Station on the Somme front. Ninety beds were set aside for men with gunshot wounds of the thorax, whom the reception officers thought had a chance to recover. It was a distressing duty day after day as chief surgeon, to make hurried rounds of these patients and consign to the moribund ward those we knew would die within the next few hours. Appalled by our helplessness in dealing with wounds of this type and the distressing and inevitable outcome up to that period, and fortunately perhaps without any time or opportunity for confirming our conclusions by animal experimentation, we decided about the middle of July 1916 to attempt to deal radically with the so-called "necessarily fatal" type of gunshot wounds of the chest. Within 1 week, 11 so-called fatally wounded men, had been operated upon and were still alive. From that time on gunshot wounds of the chest in our Unit were considered as emergency surgical cases. They were immediately sent for admission to the resuscitation wards and we realized that chest cases requiring early operative treatment required it as urgently and as promptly as did abdominal cases. Operative interference became routine treatment. Our dread of such cases decreased as new experiences proved the value of radical treatment until by the autumn of 1916, we found that we had reversed our mortality and instead of helplessly watching 78 per cent of these unfortunate patients die we were saving 78 per cent of them (Lockwood and Nixon, (1)).

Thanks to the far-sighted policy of our Director General, the Adjutant Director of our particular army the IV British Army and the consultants, we were permitted to retain all chest cases after August, 1916 whether seriously or slightly wounded, until they were up and about, and able to do light duty. In addition, our own Casualty Clearing Station and that of Colonel Pierre Duval, now professor of surgery in Paris, were placed side by side. We worked in the closest of harmony and as he had been responsible for the development of thoracic surgery in the French Army we were naturally afforded an unrivaled opportunity to study our respective methods of dealing with such wounds. To Duval and his associates, my associates and myself will be forever grateful for

their great courteousness at all times, and for constant help and advice on matters surgical.

From 1915 to 1920 as a result of the tremendous casualties of the War and the dreadful epidemic of influenza in 1918 and 1919 with its high percentage of empyema thoracic surgery developed to a greater extent than it had in all previous time.

The successful treatment of empyema, lung abscess, bronchiectasis, tumors of the chest, surgical procedures on the heart and pericardium, the lungs, mediastinum and diaphragm and now successful operations for removal of the clot in pulmonary embolus, present an unparalleled galaxy of surgical achievement in the last 17 years.

It is a question if the profession generally even yet realize the great advances in the treatment of injuries of the lung made during that period, and the urgency and possibilities of treating such wounds in civil practice. A definite percentage of deaths after automobile and flying accidents, train wrecks falling from a height, crushing injuries, and penetrating wounds of the chest are avoidable if proper care is given.

At the outset the chief problem to be faced is the recognition of those patients who recover with out operation as distinguished from those who unless operated upon inevitably die. Speaking broadly the cases in which we advise a complete intrathoracic operation belong solely to the latter group.

It is not within the scope of this address to consider all types of traumatic lesions of the thorax. It must be appreciated however that most of the deaths due to thoracic injuries are due to extensive injuries to the bony skeleton of the thorax, the so-called stove in chests. Such patients die as a rule from the shock and exhaustion of the gross bony lesions. Injuries of the lung resulting from such accidents and conditions that should be recognized are:

1. Rupture of the visceral pleura causing (a) spontaneous pneumothorax in a closed chest (b) associated with an open pneumothorax—traumatopneuxia (c) the degree of displacement of heart and mediastinum in either condition.
 2. The presence of a hemothorax—if so, how extensive?
 3. A hematoma of the lung.
 4. Rupture of a main bronchus or blood vessel with escape of air or blood into the pleural cavity or mediastinum.
 5. Contralateral collapse.
 6. Massive collapse of one or even both lungs.
- Traumatopneuxia should be immediately sought for. If present, the wound should be cleaned and without an anæsthetic the skin should be sutured

with deep silkworm gut sutures or be approximated and sealed over with adhesive plaster. The immediate improvement in such patients is often marvellous within a few minutes. The lung usually expands, the respirations become deeper, freer, and more regular, and the mental distress of such a wound is at once relieved. Such a patient can shortly be safely transported to a hospital for closer observation and further treatment.

Massive collapse of one lung and even of both lungs without any gross injury of the bony thorax occurs. This condition particularly that of bilateral collapse, we did not recognize until July, 1918, in the Ypres salient. The cause of it is difficult to explain unless due to sudden withdrawal of air due to bursting of a shell, with perhaps one intense expiratory effort and bronchial spasm. The lung or lungs were found contracted on their pedicle and were not larger than one third of the man's fist. While an excised portion would float there did not seem to be any air whatsoever in the entire lung. In such a case, the involved side is found to be absolutely silent. Place a handkerchief or a piece of gauze over the mouth, compress the nostrils of the patient, apply your own mouth to that of the patient, and blow air into his lung. The lungs can be inflated instantly, and with alternate blowing and pressure on the chest respirations can be restored. We no longer employ a pulmotor even for a patient suffering from asphyxiation.

Morphia in fractional doses should be freely administered and active resuscitatory measures taken to combat shock. Intense dyspnoea due to hemothorax or pneumothorax should be relieved before operation by aspiration. If recurring hemorrhage is suspected the aspiration should be partial and combined with oxygen replacement.

Diagnosis. As soon as the patient's condition permits, he should be thoroughly examined by the surgeon, physician, and radiographer to decide whether or not immediate operation is required.

Röntgenological examination. Röntgenological examination reveals the approximate amount of hemothorax, the presence of pneumothorax, hematoma of the lung substance, the degree of collapse of the lungs, the position of the diaphragm, heart and mediastinum, and the comminution and overriding of the ribs.

Clinical symptoms and signs. The physical examination should be limited in the first instance to ascertaining whether an immediate operation is advisable and possible.

Widespread surgical emphysema obliterates or disguises every other physical sign except the position of the heart.

Physical signs in traumatic lesions of the lung are most fallacious. Unduly moving the patient to permit of a meticulous physical examination is very unwise and the findings should not influence the decision to operate if certain indications for surgical interference exist. The bizarre findings on physical examination of traumatized chests must be realized by the examining doctors. Respiratory distress does not always accompany even the largest effusions. The degree of movement in a chest is not always proportionate to the intra-thoracic injury. Immobility may be complete without an intrathoracic lesion. Pneumothorax does not always develop rapidly after injury. It may be a late and gradual occurrence.

It has been a mystery to us why hemothorax so constantly develops in chest injuries. Seldom have we found an intercostal artery ruptured, or at least still bleeding rarely if ever have we seen active bleeding from a contused or lacerated lung except when it is held up by adhesions. Excision of a wound in the lung is associated with remarkably little hemorrhage.

Signs of increasing effusion in patients treated expectantly after 24 to 30 hours, are rarely ever due to active hemorrhage. Late secondary hemorrhage is, as a rule, due to bleeding from an intercostal artery.

Indications for operation: 1. Operate on all patients with an open pneumothorax (trauma topora).

2. Operate on all patients with laceration of the diaphragm as well.

3. Operate on all patients with a badly stove in chest with overriding fragments and sharp specules where the pleura is lacerated, even though there is no external wound.

4. Operate on all patients where a jagged irregular missile has traversed the pleural cavity whether lodged in (a) the chest wall, (b) the pleural cavity (c) the lung, (d) the mediastinum, or (e) the heart or pericardium.

5. Operate on all very acutely infected patients, even though the missile is not retained.

6. Operate on all patients with a penetrating wound of the chest with progressive bleeding, hemothorax, and massive hemothorax.

7. Operate on all patients with a massive pneumothorax and great displacement of the heart and mediastinum that cannot be controlled by aspiration.

8. Operate on all patients in whom rupture of a main bronchus or artery at the hilus of the lung is suspected.

Thoracotomy is rarely indicated for relief of the ordinary hemothorax or hematoma of the lung.

Unfortunately occasionally lung abscess or more rarely gangrene of the lung results from an extensive hematoma of the lung but unless thoracotomy is necessary otherwise, we believe such patients should be treated expectantly.

Anesthesia: Surgeons dealing with thoracic problems should have a thorough knowledge of the physics of the chest. So many fallacies have been propounded based largely on experimental studies on dogs and rabbits. Such findings have little if any value as applied to humans. The mediastinum in the dog and the rabbit is permeable to air and even fluid but that of humans is impermeable and has a certain degree of fixation. Our decision to deal radically with intrathoracic wounds in 1916 was based on the fact that investigation on cadavers had established the fact that the mediastinum of humans was not permeable to air or fluids and presented a fairly rigid barrier between two cavities. Snyder's (2) investigations in 1927 corroborate our experiences of 1915 to 1919.

The modern gas oxygen machines with a snugly fitting mask applied to the well vaselined face affords all the positive pressure necessary for re-oxygenation and offsets the danger of a prolonged open pneumothorax. Intratracheal gas oxygen anesthesia in the hands of an experienced anesthetist, should be employed for a prolonged thoracotomy.

A paravertebral anesthesia for two or three spaces above and below the wound or the site of the incision, with local infiltration, to avoid delay associated with gas oxygen anesthesia, is the anesthetic of choice. Emergency cases that would never be fit for a general anesthesia can be safely operated upon with this type of anesthesia. A more extensive, deliberate, and protracted operation can be undertaken with the minimum of shock to the patient. Respirations are deeper and more regular than with a general anesthesia, and the movements of the lung, mediastinum, and diaphragm can be voluntarily controlled by the patient to an appreciable extent. The two stage operation in which both sides of the thorax are opened, is possible only with this type of anesthesia. Postoperative restlessness, vomiting, retching, coughing and straining are avoided, and this plays no small part in the success of such operations, especially in bad risk patients.

Operation: The complete intrathoracic operation must not be lightly undertaken. The preparations for operation, the anesthetic, and the technique of the operation are most exacting although the manipulations themselves within the thorax do not require any exceptional dexterity.

Speed is essential. *Absolute asepsis must be maintained.*

For operation the patient should be placed with the injured side dependent, usually in the half sitting posture. Primary union will not result without bold thorough excision of wound area.

When the position of the wound will permit resection of the fourth rib or preferably a long incision in the interspace immediately below from the mid-clavicular to the posterior axillary line furnishes easiest access to the thoracic cavity. A powerful snugly fitting rib retractor is necessary.

The commonest source of bleeding is from a torn intercostal artery. If the artery cannot readily be picked up and ligated with a small penosteal needle a suture can be passed around it or failing that around the rib itself.

The lung can be freely handled incised or a wound excised as required. If the wound is of a gaping type in the lung tags of intercostal fascia and muscle should be laid over the edges and sutures passed through them will relieve tension on friable lung tissue when the edges are approximated. Bronchial fistula will invariably be avoided if the visceral surfaces are carefully apposed.

Partial or even complete lobectomy may be necessary, depending on the degree of laceration of the lung. In such a case preserve plenty of the visceral pleura.

An open bronchus or alarming hemorrhage from the lung surface is rarely found at operation.

The toilet of the pleura must be meticulous.

The thoracotomy incision should be closed with a thick, moist towel every moment that the hands of the operator are not within the thorax.

Time should not be wasted in attempting to repair the parietal pleura.

The chest must be hermetically closed with the first layer of muscles otherwise pocketing will occur, pleural effusion accumulate, the incision break down, and an empyema result.

Careful approximation of the skin edges is necessary to insure early absolute primary union.

Drainage of the chest should never be employed in these primary operations.

Gross injuries of the bony wall of the chest associated with injury to the lung require that all comminuted bone and sharp spicules be widely excised. If the intercostal nerves have been torn, employ alcohol injection proximally to offset pain during convalescence.

Postoperative treatment. The postoperative treatment of chest wounds demands constant attention. The patient should be maintained in

the position found to be most comfortable. Oxygen should be employed if the patient is cyanosed. Morphine should be freely used to combat restlessness.

Aspiration should be carried out 18 hours after operation and as frequently as necessary to keep the pleural cavity relatively free of fluid. Early fluoroscopic examination or roentgenograms will help to determine the presence of a collection.

CONCLUSION

1. Grave traumatic lesions of the chest are still being overlooked, and are not being dealt with radically as they should be.

2. First aid instruction as to the necessity, urgency and methods of immediately sealing off a penetrating wound of the chest to overcome the ill effects of traumatopnea is advisable.

3. All such patients should be given morphine early.

4. Massive pneumothorax should be looked for.

5. Active resuscitatory measures are necessary. In the majority of such cases blood transfusion is required.

6. The urgency of recognizing whether or not the thoracic lesion is the main cause of the patient's condition cannot be overemphasized.

7. The indications for thoracotomy are well defined.

8. The complete intrathoracic operation is a serious one and not lightly to be undertaken.

9. A select anesthesia must be employed.

10. Speed in operating and absolute asepsis are essential to success.

11. The operation must begin with *excision in toto* and end with hermetically sealing of thorax.

12. Fluid should not be allowed to collect in the pleural cavity after operation.

13. Resection and drainage secondarily should be a last resort. It is rarely necessary and should be employed only after multiple aspirations and if necessary catheter drainage has failed.

In no class of surgery is teamwork more essential to success. The surgeon, physician, radiographer, and anesthetist should work hand in hand. The theater staff must have everything prepared in advance and be quick and methodical, knowing each step in the operation, thereby avoiding delay. After operation nurses who are experienced in caring for such patients should, if possible, be employed.

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SILICOSIS AND OTHER DUST DISEASES

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A DEPOSIT of silica in the lungs can never be removed. The health hazards to the operators on these dangerous jobs can all be eliminated, not only in such a way as to protect the operator but incidentally with a saving in production costs.

Silicosis, far from being a new disease was described by Ramazzini in 1700. The first American study was made by Lanza and Higgins, among the lead and zinc miners in the Joplin, Missouri district in 1914. Of the 770 miners examined 330 or 45.8 per cent, had silicosis in some stage 105, or 14.5 per cent, had silicosis with tuberculosis and 30 or 5.4 per cent, had tuberculosis alone.

Definition and etiology. Silicosis may be defined simply as a specific form of pneumoconiosis due to breathing air containing free silica dust—identified anatomically by generalized pulmonary fibrosis and the development of milary nodulations in both lungs clinically by shortness of breath decreased lung expansion, lessened capacity for work increased susceptibility to tuberculosis, and characteristic X ray findings.

It was formerly thought 10 years exposure was necessary for its production. Recent reports indicate that cases have occurred within 3 to 5 years exposure. The Canadian laws are based on an exposure of from 3 to 5 years.

The principal industries in which silicosis appears are (1) mining, (2) quarrying, (3) stone finishing, (4) pottery, (5) abrasives, (6) glass, (7) mineral earth (8) spray coating, (9) refractories, and (10) construction.

Diagnosis. The diagnosis of silicosis rests on proof of adequate industrial exposure. Symptomatology physical and X ray findings the X ray findings being the most important.

In the *symptomatology* the outstanding preliminary complaints are non-productive cough and shortness of breath. These symptoms become more pronounced as the disease progresses. The X ray evidence is characteristic.

Pathology. According to Gardner in the initial stages the phagocytes are apparently irritated by ingested particles, transporting dust particles to points where intimate contact is established with connective tissue cells. Active proliferation of fibrous tissue continues after this stimulation and an extensive reticular network developed. Later

in the process a tendency to the development of discrete nodules is observed and hyaline degeneration of the nodules may take place. The normal flow of lymph from the lungs is interrupted by extensive damage and replacement by fibrous tissue in the tracheobronchial lymph nodes although the original degeneration of tissue is not due to an ischemic effect, but is essentially a local manifestation of the toxicity of free silica or quartz dust.

Prognosis. Prognosis depends upon the stage of development of the disease but is always grave from a curative standpoint when the changes are sufficiently advanced to be recognized clearly. The prevention of silicosis may be accomplished through observance of the following procedures:

1. A careful occupational history paying particular attention to previous exposure to free silica hazards the exclusion of those who have had exposure which might be hazardous, the exclusion of the tuberculous, and the refusal of employment to persons who are experienced in occupations involving a free silica hazard.

2. A careful physical examination and X-ray of the chest of all employees before going on work involving free silica hazards.

3. The provision of proper types of exhaust ventilation equipment, adapted especially to the processes involved.

4. Personal respiratory protection of an adequate and approved type, according to the manufacturing processes concerned, with proper provision for maintenance and supervision.

5. A periodic physical examination together with X ray examination of the chest at appropriate intervals, according to the severity of the exposure, the type of work done, and other detailed factors.

ASBESTOSIS

Asbestosis occurs with considerably less frequency than silicosis, although enough clinical and pathological material is now available for adequate study.

The disease may be defined as a specific form of pneumoconiosis due to breathing air containing asbestos dust, based on concentration and length of exposure. It is characterized anatomically by a generalized pulmonary fibrosis—clinically by shortness of breath and decreased

lung expansion and by X-ray findings which differ from those of silicosis.

Lynch and Smith surveyed all available literature on the subject in 1931 and collected 172 cases of pulmonary asbestosis. These observers stated that necropsy has been made in 18 cases, that including the first case recorded (that of Murray in the *Charing Cross Gazette* of 1900)

there are now four records of necropsy on uncomplicated pulmonary asbestosis. Most of these cases developed in the British Isles with the exception of a few reported by Simson in South Africa, by Lynch and Smith and by Pancoast and Pendergraft in the United States. Apparently the first American case recorded was reported by Soper in December 1930.

OCCUPATIONAL DISEASES

MEDICINE & UNCLAIMED PROVINCE!

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THE first factory in America probably was located in Jamestown, Virginia, in 1609.

There Captain John Smith's little bands of pioneers made glass beads and similar baubles for trade with the Indians.

In this primitive foothold of American industry the threat of occupational diseases existed. Using the sands of the James River and lye leached from the wood ashes of their fireplaces, these first industrialists potentially were exposed to the causes of two occupational diseases that today stand out respectively as the commonest of such diseases and the most direful. Lye long has been a source of occupational skin disease—this country's most common significant trade affliction. Silica dust is the cause of silicosis—this country's foremost industrial disease problem. Occupational diseases thus have grown up with the country.

These two hazards, lurking in the first factory of 1609, have so multiplied until at this very time no fewer than 1,000 dissimilar dangers threaten the well-being of this country's workmen. These hazards are to be found in the vapors, gases, fumes, dusts, toxic liquids, noises, unusual chemical and physical rays, industrial bacteria, and many other creations of this country's far-flung industrial pursuits.

Today recognition is given to some 7,000 different occupations. Of these approximately four fifths are associated with some degree of prospective harm for the exposed workman. This number does not include as prospective traumatic injuries, which are distinct from occupational diseases, in that commonly they are swiftly produced, while long exposure is the rule in the case of occupational diseases. This may be clarified by

the simple example of a workman who uses an air drill in digging up a concrete roadway. A chip of concrete may lacerate the eye, thus immediately producing an obvious accidental injury. On the other hand, day by day vibrations of his pneumatic tool may slowly lead to a tenosynovitis. This latter is not a fortuitous circumstance and the condition resulting from the sustained exposure constitutes a characteristic occupational disease. Although time is the essence of separation of industrial accidents from occupational diseases, no fixed time may be set as the demarcation line.

Some justification exists for maintaining that as many as 1,000 distinct occupational diseases may exist. However, while there may be 1,000 distinct causes of occupational diseases, the number of clinical entities is much less, owing to the fact that manifestations are essentially the same for many different industrial afflictions. Notably this is true of industrial dermatitis. Some idea of the frequency of cases of occupational diseases may be gained from the assertion that yearly 50,000 cases of occupational skin diseases alone take place. Other forms of occupational lesions are not proportionately large, but in the aggregate the yearly total throughout this country is enormous.

If in fact, it is proper to recognize approximately 1,000 different occupational diseases, this number is believed to constitute the largest number of diseases falling into any one subdivision of medicine. However, with few exceptions, the number of cases of any one type of occupational disease in any one community is likely to be small. No less in every industrial area, week by week happenings like the following are likely to take place:

A. Recently in one city a department store worker presented herself to the physician in charge complaining of asthma. The faithful physician carried out numerous protein sensitization tests from feathers to pollens, without avail. The taking of a more careful work history would have disclosed that this department store worker was employed as a fur worker in the alteration room.

On cheap furs the brown and the black color may be procured through the use of *para-phenylenediamine*. This substance is a well known source of asthma, and this patient was suffering from a characteristic occupational disease.

B. In a low type of tobacco plant, two workmen were engaged in the reclaiming of scrap tobacco. This is a dusty process. Both of the men developed a disease characterized by peripheral neuritis, gastro intestinal involvement, upper respiratory tract inflammation, and loss of hair.

These two men were suffering from *arsenic poisoning*—due to the fact that in the growing of tobacco the plants are sprayed with an arsenic containing insecticide. This arsenic is retained on the leaves to some extent, and, given high concentrations of dust, arsenic poisoning is a reasonable expectancy.

C. In many cities the depression has caused persons to engage in dry cleaning on a petty scale. Fire regulations prevent the use of gasoline, kerosene, solvent, benzol, etc. Frequently these workers carry out dry cleaning in their homes—or in the rear of some other business building, using carbon tetrachloride as the flame proof detergent. *Chloroform poisoning* may be the result.

D. For long time *linalin* insect powder which is made from chrysanthemum buds, was dusted about our homes in the elimination of insect pests.

Nowadays, it is customary to leach out the chrysanthemum buds with a solvent such as *ethylene dichloride* or *dichloroethane* and to spray the resulting fluid extract into the air. Both the solvent and the powder are toxic, and poisonings have arisen both in manufacturing plants and households. In the former the condition constitutes an occupational disease—in the latter a non-occupational affection.

E. During the hunting season for rabbits we find another example. Among the many butchers who dress rabbits for the market, several may prick or cut their skins—and *tetanus* may develop. Under these circumstances *tetanus* constitutes a clear-cut occupational disease.

F. Many workers, in cleaning up after a day's work, favor the use of abrasive soaps. The abrasive employed is likely to be *silica* or *silicate*. The makers of this type of soap are far removed from granite quarrying, sandstone cutting, or sandblasting, but no less *silicosis* may arise among them.

G. Saw mill hands are not infrequently engaged in handling logs that long have been floated about in mill ponds. These logs are likely to be covered with a rich growth of *fungi* (molds). Certain of these *fungi* are pathogenic and pulmonary diseases due to *fungi* are to be recognized as occupational.

Occurrences of occupational diseases such as the foregoing are frequently taking place all about us. These diseases reach into every specialty in medicine—not excluding surgery. In substantiation, I am citing the following:

A. In an eastern plant a number of workers proved to be suffering from bladder tumors. It was observed that all these workers came from one department. It was further observed that all were working with *benzidine*.

These cases, now under observation, are regarded as *benzidine tumors*; but other derivatives of aniline oil are

known to be capable of producing similar neoplasms. These conditions are clearly within the domain of surgery.

B. *Silicosis* is followed, in a high percentage of incidence, by *tuberculosis*. In the treatment of ordinary tuberculosis, surgeons frequently resort to collapse of the lung. At once the question arises as to whether or not tuberculosis in a lung made dense by previous silicosis may be collapsed, and whether or not this is a desirable procedure. At the present time the answer to this question is not known, but some responsibility for the proper solution rests upon the surgeon.

C. *Zinc sulphate*, as formed about galvanizing plants, is quite capable of causing ulcers of the stomach and duodenum. To a lesser extent this is true of other metals and metal salts. The incidence of gastric ulcers among lead workers is considerably higher than for all workers.

D. Many thousands of workers in this country are exposed to *oils* and other *coal tar* or *petroleum derivatives* containing carcinogenic agents.

In England the frequency of *bar cancers* among textile workers makes of this a foremost problem. In this country either the incidence is lower or the recognition of cancers as occupational in origin is not accomplished.

These and many other occupational disease problems, clearly fall within the domain of the surgeon. Associated with the majority of all trades are clear cut dangers, leading to disabling and life-shortening abnormalities. Something may be gained by citation of one example chosen at random.

The uninitiated are unlikely to see any real dangers in the work of a metal polisher or buffer sitting or standing for 8 hours a day bringing various small metal objects into contact with a revolving cotton wheel or a similar wheel to the edge of which emery powder has been glued. To the initiated a number of distinct occupational disease hazards exist. These I am briefly enumerating.

1. Lead is nearly always present as an impurity in buffed or polished metals. Some metal parts so treated, are composed entirely of lead, or contain a high percentage of lead, 60 or 80 per cent, for example. Some lead articles are polished and buffed without plating, which means that any metallic dust generated is necessarily lead.

2. Some buffing wheels, or *adjuvants* used in buffing are *siliceous* particularly is this true in sand buffing. Although the sand may be treated with oils to prevent dust and to promote buffing, siliceous dusts are no less developed and *silicosis* is known to exist among these workers.

3. The revolving polishing or buffing wheel is never a circle due to inescapable unevenness. This leads to jerking and pulling on the hands holding the object against the wheel, which may eventuate and practically does eventuate, in *tenosynovitis* and kindred inflammations.

4. The polishing materials vary widely depending upon the metals being finished. Many of these

are skin irritants, of which chromium used in the buffing of chromium plated articles is the most dangerous. In other polishes silica or silicates are included.

5. On certain plated objects coming up to the polishers and buffers there is a scum or film. This is likely to be partly composed of the plating materials in spite of the fact that one or more washings may have followed submersion in the plating material. In chromium plating such a film is well known. Here is a small hazard for the production of skin diseases among polishers and buffers.

6. If the objects to be polished or buffed have bright surfaces as they usually do they may so reflect overhead lights as thus to produce a specular glare and create an eye hazard for the workman.

In addition to these characteristic hazards there are certain other important, but non-characteristic, ones. Tuberculosis rates are enormously high among polishers and buffers. The reason for this is perhaps several fold including the miscellaneous dusts provided and the posture assumed in polishing and buffing which limits breathing. This situation is well summed up by Hayhurst, who states. Especially should medical supervision be adopted for polishers and buffers as they are at a process which appears to take about 20 to 25 years off of their lives.

In the stream of constructive endeavor in industrial human relations occupational diseases have long been caught in an eddy. In the causation of this eddy the medical profession has played a prominent and unpraiseworthy part. The reason for this readily may be delineated. The ingenuity of the industrial chemist long has set too rapid a pace for the physician. By the time that the physician has familiarized himself with one set of hazards, the chemist has created substitutes which at times are equally dangerous. By the time the physician came to accept benzol as a highly treacherous solvent—the chemist was thinking in terms of glycols, higher alcohols, chlorinated hydrocarbons, xylenols, etc. The physician seeks refuge in what has now become a medical aphorism—*'Occupational diseases do not lend themselves to ready diagnosis'*. To the contrary, occupational diseases more than any other class of diseases of large numbers, lend themselves to precise and exact diagnosis!

The citation of excerpts from a single case may emphasize this situation.

A few years ago, a patient presented himself at the dispensary of a large hospital, giving his occupation as a windowshade maker and complaining of a widely distributed skin lesion. In the absence of a positive Wassermann, and

because of an earlier history of possible lues a diagnosis of that condition was made, and this patient was given arsenicals. The condition became worse and this afflicted patient sought no further treatment.

Shortly thereafter he appeared in another hospital as a house patient where, after consultation, a diagnosis of Hodgkin's disease was made for which there was some justification. The physician in charge was a tried to remove his patient to a home for incurables, since the prospects of recovery were negligible. However before actual removal this patient developed a thrombo-angitis in an extremity and a diagnosis of Buerger's disease was made. Later in the home for incurables, the physician recommended the removal of all teeth because of oral infection. The patient did not improve. However after many months, this man apparently did recover and worked for 3 years. During this time a full measure of the true facts had come to light. This patient was, in fact, a windowshade maker. However he worked as a pigment blender in the windowshade coating room—and analysis of these pigments disclosed a well known intoxicant as an impurity in the majority. This same toxic substance was found in the cut hair of the patient—in his urine—and in his blood. This patient's skin lesion—loss of nails—loss of hair—the angitis—the bronzing of his skin—all might have been attributed to the action of this intoxicant. *This workman was suffering from an occupational disease—arsenic poisoning!*

It is to be doubted that the defensive aphorism *'Occupational diseases do not lend themselves to ready diagnosis'* is a proper substitute for a generous lot of divine inquisitiveness.

As a result of the general situation contemplated occupational diseases represent a field of medicine much shunned by the great majority of physicians and surgeons. As a further result, much of the so-called authoritative medical testimony before courts is not only ludicrous but constitutes a prostitution of good medicine. Caution and good faith deter the good physician or surgeon from participating in court work when he is not on familiar footing. Consequently, testimony with respect to occupational diseases too often is of a low order—emanating from the mouths of so-called 'experts,' who, in fact, are illly qualified to present facts.

Recently during the life of a patient, who subsequently died, a consultant made a diagnosis of "chronic benzene poisoning." The family physician, being less versed in occupational diseases than in alkaloidal poisoning without evil intent, made his many court reports to read "chronic bromine poisoning." It is quite unlikely that the victim ever saw any bromine, yet the financial integrity of this dead man's dependents was jeopardized by this physician's act.

Not long ago I heard a reputable surgeon testify in a court, dealing with an occupational disease claim, that dusts entering the lungs exert a beneficent action. Dusts, it was affirmed, by their gentle irritation of the respiratory tract, serve to tone the tissues against infection. The *Journal of the American Medical Association* recently published a court decision in which lead poisoning (in Idaho) was adjudged to be an accident and not an occupational disease, because the period of exposure was only 3 weeks, and thus too short a time to produce an occupational dis-

case. Behind this travesty and I trust this remark constitutes no contempt of court, undoubtedly lies the testimony of some one or more physicians.

Failure to accept responsibility for occupational disease is hurtful to the status of the entire medical profession. Failure to delve into the precise activities of a worker who has become a patient frequently paves the way for much social injustice and medical inaccuracy.

In 1700 Ramazzini, the forerunner of occupational disease work, in his *Diseases of Artificers and Tradesmen* soundly observed in the preface that every physician should not only ask his patient— "what uneasiness he is under, how many days he has been ill, how his belly stands, what food he eats" but also "what trade is he of? If that interrogation was important

two hundred years ago, how much more needful is it today! Moreover it is not sufficient to ask,

"What trade is he of?" for in our day most trades are highly subdivided. In Ramazzini's time it was sufficient to establish that a worker was a shoemaker but today the shoemaker's work is divided into three hundred operations, from archers to welt makers, each with its particular degree of danger for the exposed workman.

Whether or not the physician wills it, he is faced with the fact that occupational diseases are real, numerous, severe, and costly. So clearly do they fall within the field of the practice of medicine that they may not be ignored. During the work decades of life second only to infection, occupation is the most potent cause of incapacity!

THE CARE OF EMPLOYEES IN INDUSTRY BY PHYSICIANS AND SURGEONS IN INDEPENDENT PRACTICE

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THE scope of this paper concerns the care of employees in industry by physicians who are not engaged in a full time capacity with one corporation. As the companies with which such physicians deal are usually small, a physician may have connections with a few or with a great many corporations depending upon their size and the percentage of the physician's practice which is in industrial in type.

About 99 per cent of the corporations in this country employ less than 1,000 men and in this 99 per cent are employed about 30,000,000 men and women. Of this vast number of employees, perhaps 80 per cent are employed by corporations which do not have full time physicians hence are given industrial care by doctors in independent practice. These figures furnish ample evidence of the importance of this subject. They should focus the attention of every physician who elects to treat the industrially disabled upon the obligation attached thereto likewise they should impress all medical organizations and physicians who though not interested individually in industrial care, should be responsive to the duties of the medical profession in this rapidly growing field of endeavor.

In the industrial centers where corporation practice is more standardized, private and industrial practice are not readily miscible, so physicians who having a liking for corporation practice or for traumatic surgery and whose industrial contacts show gradual enlargement, soon find themselves practically full time in their field of endeavor even though not full time with any one corporation. The special fields of traumatic surgery and of industrial medicine (whether considered separately or linked together) are of such scope as to merit the fullest recognition by the medical profession and the public. This recognition is vital if these specialties are to keep pace with the increasing demands made upon them.

In this industrial medical evolution some physicians, inclined toward the medical side of practice have emerged as specialists in industrial medicine and hygiene, others, surgically bent, prefer to be known as specialists in traumatic surgery. In both instances conducting a concurrent private practice is usually precluded. It is fitting therefore, that those qualified receive recognition as specialists in their field and that such recognition

be based on ability and not on the mere fact that a physician is confining his major activities to industrial practice. This process of selective recognition will attract young physicians of higher caliber to this field which will redound to the benefit of the employees in industry.

A physician dealing with many widely diversified industries has the opportunity of developing a breadth of outlook and a wealth of experience which is obtainable with much greater difficulty by a physician spending his entire time with one corporation unless that corporation is extremely large. At the same time he is subject to the disadvantage of not having sufficient intimacy of contact with any one company to enable him to fulfill many of the requirements of a complete industrial service.

Fundamentally, all employees are entitled to the same standard of medical supervision and service irrespective of the size of the company and regardless of whether a full time physician is in charge or a part time doctor in independent practice. Assuming this inherent right of the employees what are the essentials of factory medical service?

Briefly, the duties which a plant physician should be called upon to perform are the following: the care of those injuries, diseases, and abnormal conditions covered by the compensation law; the rehabilitation of the industrially disabled, conducting pre-employment medical examinations and periodical re-examinations during employment, the eradication of accident and health hazards, the prevention of the spread of communicable diseases in the plant, the regulation of factory hygiene and sanitation, co-operation with the employment manager in the selection of jobs to fit the physical and mental status of the individual, the supervision of physical defects and ailments not caused by employment in order to maintain efficiency and prevent loss of time; general health instruction to the factory personnel and finally the maintenance of a friendly contact with the employees' family physicians. In this latter connection it is understood that the domain of the family doctor is not invaded. On the contrary, the insistence of the plant physician will send many patients to their own doctors for the correction of physical defects or the care of bodily ailments, often unrecognized previously.

Now If we scrutinize the foregoing duties of the plant physician how many of them do we find performed in the average instance? Unfortunately in most cases we find the physician's contact with a factory practically limited to the care of accidents and diseases for which the employer is legally responsible. Are the physicians so negligent in their realization of the potential possibilities of an adequate industrial service or are there other fundamental factors at fault? Much has been said about the ineffectiveness of physicians in dealing with industrial problems—and there is no denying there is some justification for this criticism—but far too little has been said concerning the backwardness of corporations in recognizing the necessity for a complete medical service. It can be stated with confidence that practically every physician in independent practice would be only too glad to comply in so far as he is able with any request made by any company for some service in addition to the routine care of the injured. But such requests are so seldom forthcoming as definitely to dampen any enthusiasm with which the physician might be unbued to enlarge the scope of his affiliation with the factory. This apathy of the smaller corporations is exceedingly deterrent in frustrating the right of their employees to receive the same degree of general medical supervision obtained by those employed by larger corporations having full time physicians.

Our profession should aid in sponsoring an intensive educational campaign to apprise the heads of corporations with the dividends which an adequate medical service pays. Likewise, the matter should be brought before the labor organizations and before the public. If industry makes the demand, surely the medical profession will meet it, just as it almost invariably has met other demands in the past. Physicians doing a small amount of corporation practice who might not be ideally prepared to meet these new phases of industrial service either would have to equip themselves mentally to meet the new conditions or else risk losing whatever corporation contacts they might have acquired. Education of the profession, while essential, will be futile in solving the problem unless corporation consciousness is concurrently awakened.

The apathy displayed by most corporations toward their medical service is almost incomprehensible. The average factory superintendent engrossed in his study of production costs, pays little heed to the care of his sick and injured, seemingly oblivious to the vital, though somewhat intangible, rôle the welfare of his workers plays in his balance sheets. Before relegating the care of

his employees to a certain physician, the head of a factory should investigate that physician's qualifications with the same degree of care exercised in the selection of a physician for his own family.

Another factor in causing this disinterest of the employer arises directly out of the placing of compensation insurance. After receiving insurance coverage, the employer only too frequently selects any conveniently located doctor or accepts without question the physician designated by the insurance carrier. Having paid his insurance premium he is disinclined to expend further funds, feeling that he has met the requirements of the compensation law and that the burden now rests with the insurance company. The insurance carrier quite naturally is concerned only with fulfilling the requirements of the policy in force and thus all the employee receives is minimal service. It is obviously impractical for most corporations to be self insurers but if they were they would be far more analytical and critical in their selection of medical service than they are now.

A similar situation exists in connection with pre-employment examinations, the great value of which is appreciated by all physicians doing industrial practice but is absolutely unappreciated by the vast majority of the smaller corporations. Such examinations are not inimical to the work men, any criticism from their standpoint being more than offset by the early detection of unrecognized physical defects and ailments. Any overtures in this connection made by the plant physician are likely to be viewed askance by the company officials, both on account of the cost and because they are likely to feel the physician is merely trying to increase his own revenue. Were such examinations made legally compulsory both the employer and employee—and that means industry as a whole—would benefit.

Though perhaps apparently irrelevant to this subject the custom of carrying compensation insurance actually has a very decided effect on the relationship between the factory and the physician in independent practice. As such insurance coverage is and doubtless will continue to be an almost universal procedure a study of remedial measures would be timely. For example, if the workmen's compensation laws contained provisions covering the needed additions to the present limited medical service, the situation would be clarified greatly. This would necessitate either corresponding changes in insurance policies to include the additional coverage or better still, would legally force the employer to assume these new responsibilities independent of the insurance carrier. This should

eventually bring him to a realization of the value of the measures involved.

At first thought this might appear to throw an additional burden on the employer. Even if it were a burden it would be justified by the existing need but actually any increased initial cost would be amply repaid by increased industrial efficiency yielding dividends which, though somewhat in tangible, would be none the less real.

And the physician when treating a patient afflicted with an occupational disease or injury should not focus his attention exclusively on the affected part but give thought to that individual as a whole further he should be cognizant of the fact that that individual is an integral part of an industrial organization, and still further, he should bear in mind that the same individual is a definite part of a social order.

METHODS OF EVALUATING EXTENT OF INJURIES

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PHYSICAL disability means a limitation of normal use of the body or parts of the body.

In industry physical injury brings about anatomical and physiological changes which alter the earning capacity and for which society attempts to compensate the individual. The physician, because of his knowledge of the human organism, is called on to analyze and measure the

newly acquired limitations. Difficulties arise, however, when he attempts to evaluate the clinical evidence of physical disability in terms of loss of working capacity. There seems to be no suitable measuring rod as yet devised no definite basis of reasoning no common ground upon which conclusions and opinions may rest. From the medical standpoint there is no reason why the extent of disability and its evaluation should not be diagnosed through just as logical and systematic manner of reasoning as is employed in diagnosing disease.

Most compensation laws base the extent of disability award on anatomical loss rather than on functional incapacity. Amputations at certain points, for instance, have specific awards. If only partial loss has occurred, however, the award can be determined only by apportioning whatever extent the percentage of partial loss approaches the total loss anatomically. That is, if the part is not entirely lost, of what value is it, compared to total loss? At this point the question ceases to be simply one of anatomical deficiency. The lost value of the part no longer can be estimated by its altered shape, size, or motion. It must be measured by establishing the amount of use the part will be to the individual since the changes in shape, size, losses of motion, or other alterations have taken place. It is within the scope of medical science therefore to determine the loss of function, thereby formulating an opinion, expressing the extent of loss.

The extent of evaluation is usually asked for in terms of percentage. A convenient measuring rod, therefore, would have a scale of one hundred units of working capacity. The various factors which constitute normal function for working capacity can be given an estimate of importance by establishing their percentage value on the scale of one

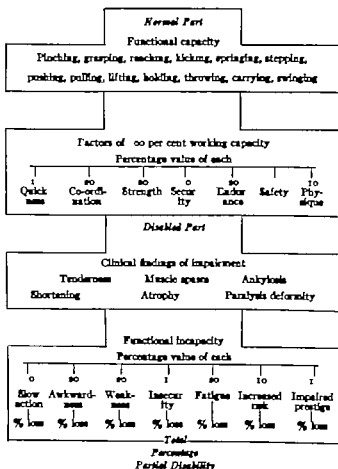


Fig. 1 Basis of evaluation

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The apathy displayed by most corporations toward their medical service is almost incomprehensible. The average factory superintendent engrossed in his study of production costs, pays little heed to the care of his sick and injured seemingly oblivious to the vital, though somewhat intangible, rôle the welfare of his workers plays in his balance sheets. Before relegating the care of

his employees to a certain physician the head of a factory should investigate that physician's qualifications with the same degree of care exercised in the selection of a physician for his own family.

Another factor in causing this disinterest of the employer arises directly out of the placing of compensation insurance. After receiving insurance coverage the employer only too frequently selects any conveniently located doctor or accepts without question the physician designated by the insurance carrier. Having paid his insurance premium he is disinclined to expend further funds, feeling that he has met the requirements of the compensation law and that the burden now rests with the insurance company. The insurance carrier quite naturally is concerned only with fulfilling the requirements of the policy in force and thus all the employee receives is minimal service. It is obviously impractical for most corporations to be self insurers but if they were they would be far more analytical and critical in their selection of medical service than they are now.

A similar situation exists in connection with pre-employment examinations, the great value of which is appreciated by all physicians doing industrial practice, but is absolutely unappreciated by the vast majority of the smaller corporations. Such examinations are not inimical to the workmen, any criticism from their standpoint being more than offset by the early detection of unrecognized physical defects and ailments. Any overtures in this connection made by the plant physician are likely to be viewed askance by the company officials, both on account of the cost and because they are likely to feel the physician is merely trying to increase his own revenue. Were such examinations made legally compulsory both the employer and employee—and that means industry as a whole—would benefit.

Though perhaps apparently irrelevant to this subject the custom of carrying compensation insurance actually has a very decided effect on the relationship between the factory and the physician in independent practice. As such insurance coverage is and doubtless will continue to be an almost universal procedure a study of remedial measures would be timely. For example, if the workmen's compensation laws contained provisions covering the needed additions to the present limited medical service, the situation would be clarified greatly. This would necessitate either corresponding changes in insurance policies to include the additional coverage or better still would legally force the employer to assume these new responsibilities independent of the insurance carrier. This should

eventually bring him to a realization of the value of the measures involved

At first thought this might appear to throw an additional burden on the employer. Even if it were a burden it would be justified by the existing need but actually any increased initial cost would be amply repaid by increased industrial efficiency yielding dividends which though somewhat intangible would be none the less real

And the physician when treating a patient afflicted with an occupational disease or injury should not focus his attention exclusively on the affected part but give thought to that individual as a whole further, he should be cognizant of the fact that that individual is an integral part of an industrial organization and still further, he should bear in mind that the same individual is a definite part of a social order

METHODS OF EVALUATING EXTENT OF INJURIES

EARL D MCBRIDE, M D F A C S., OKLAHOMA CITY OKLAHOMA

PHYSICAL disability means a limitation of normal use of the body or parts of the body

In industry physical injury brings about anatomical and physiological changes which alter the earning capacity and for which society attempts to compensate the individual. The physician, because of his knowledge of the human organism is called on to analyze and measure the

newly acquired limitations. Difficulties arise, however, when he attempts to evaluate the clinical evidence of physical disability in terms of loss of working capacity. There seems to be no suitable measuring rod as yet devised, no definite basis of reasoning no common ground upon which conclusions and opinions may rest. From the medical standpoint there is no reason why the extent of disability and its evaluation should not be diagnosed through just as logical and systematic manner of reasoning as is employed in diagnosing disease.

Most compensation laws base the extent of disability award on anatomical loss rather than on functional incapacity. Amputations at certain points for instance have specific awards. If only partial loss has occurred, however, the award can be determined only by apportioning whatever extent the percentage of partial loss approaches the total loss anatomically. That is, if the part is not entirely lost, of what value is it, compared to total loss? At this point the question ceases to be simply one of anatomical deficiency. The lost value of the part no longer can be estimated by its altered shape, size or motion. It must be measured by establishing the amount of use the part will be to the individual since the changes in shape, size, losses of motion or other alterations have taken place. It is within the scope of medical science therefore to determine the loss of function, thereby formulating an opinion, expressing the extent of loss.

The extent of evaluation is usually asked for in terms of percentage. A convenient measuring rod, therefore, would have a scale of one hundred units of working capacity. The various factors which constitute normal function for working capacity can be given an estimate of importance by establishing their percentage value on the scale of one

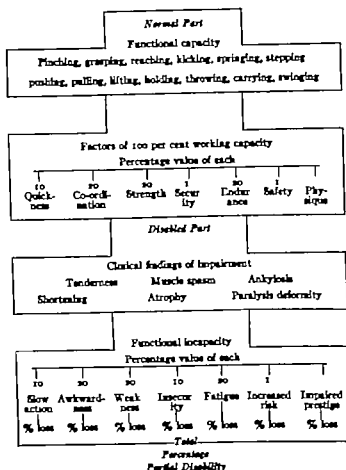


Fig. 1 Basis of evaluation

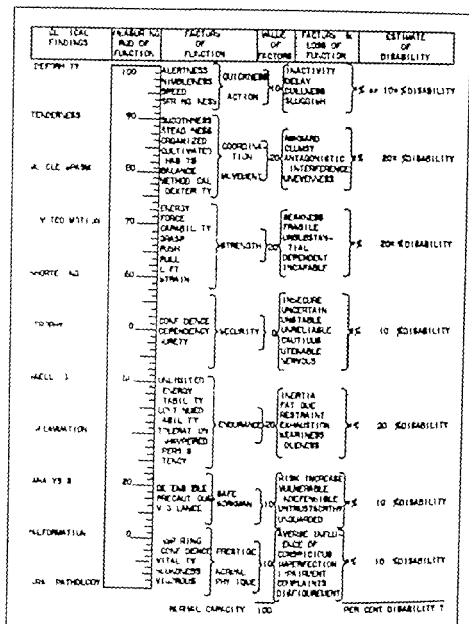


Fig. 2. Evaluation of extent of disability

hundred per cent measuring rod. Their total then would be one hundred per cent. An analysis of the functions of the body from the working capacity standpoint, would seem to be amply expressed in five principal factors, which make possible such acts as grasping throwing jerking, pulling, pushing, turning bending lifting, walking jumping and running. These factors are

1. *Quickness of action*, indicating alertness, nimbleness, and speed.

2. *Co-ordination of movements*, indicating smoothness of action, steadiness, dexterity or a synchronizing of movements resulting in proficiency, deftness and good control.

3. *Strength*, indicating physical energy force of intensity power of action as well as muscular ability.

4. *Security*, indicating confidence, habitual trustworthiness and reliability without conscious effort.

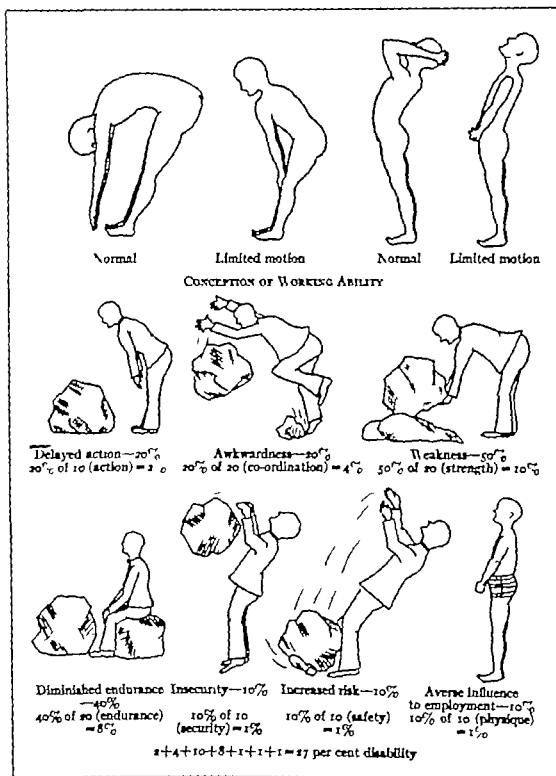


Fig. 3. Evaluating a back disability

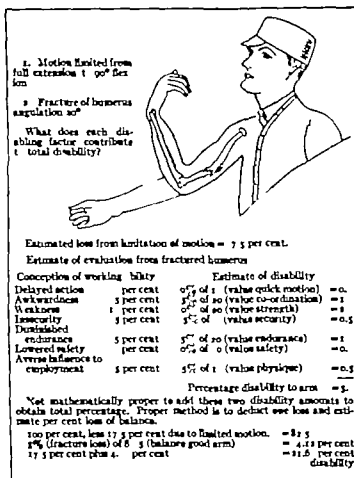


Fig 6 Multiple disability to arm.

5 *Endurance*, indicating toleration vigor, and continuation of activity without interruption.

In respect to industrial injuries, two other factors may be placed on the scale

1 *Safety*, indicating ability to protect oneself and others

2 *Prestige* of normal physique and apparent competency in seeking or retaining employment.

These functional factors may be applied to specific parts of the body. In the hand they would be stated as follows (1) quickness and nimbleness of digital action (2) co-ordination of fingers and thumb in apposing finger tips to thumb and thumb to fingers and palm (3) strength of grip and fast making ability striking slapping holding and pushing power (4) security or reliability of delicate finger sense and dependability on life long habitual and technical finger accomplishments, (5) endurance of punching holding or gripping action.

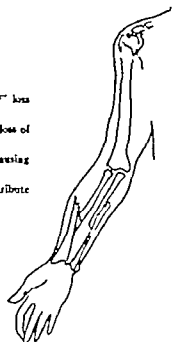
In respect to the leg, foot and toes, the factors may be considered as follows (1) quickness nimbleness springiness of step and gait (2) co-ordination of feet and toes in smoothness and steadiness of step and gait (3) strength of weight

1 Contraction causing 25° loss of index finger

2 Fracture causing 50° loss of hand

3 Aakylwed shoulder causing 50° loss of arm

How much does each contribute to loss of entire arm?



All disabilities must be reduced to terms of loss of arm

Law may allow 35 weeks for loss of index finger

Law may allow 200 weeks for loss of hand

Law may allow 250 weeks for loss of arm

To find per cent finger is to arm—

Divide 35 by 250 and result is 14%

To find per cent hand is to arm—

Divide 200 by 250 and result is 80%

To estimate loss of finger in terms of loss to arm—

15% loss of finger is 25% of 25 or 3.75% loss of arm

50% loss of hand is 50% of 80 or 40% loss of arm

On basis of percentage method, 1 determine total loss—

100—1.5 (finger loss evaluation) leaves 98.5% good arm

20% (hand loss evaluation) of 98.5 = 19.7% loss credited to hand

60 = 38.8 = 57.2 balance good arm

50% (shoulder loss) of 57.2 = 28.6% loss to arm at shoulder

Therefore 33 + 38.6 + 28.6 = 100% loss of arm

Fig 7 Disability to parts of arm each having specific award.

bearing and power of action in standing walking running or jumping (4) security or reliability of toe, heel or foot action in habitual and technical accomplishments of life long development, (5) endurance of gripping power of toes, toleration of continuous action.

The method is graphically presented in Figures 1 and 2

The scale of the rule is graded as follows

Quickness of action	value 10 per cent
Co-ordination of movements	value 30 per cent
Strength	value 30 per cent
Security	value 30 per cent
Endurance	value 30 per cent
Safety factor	value 10 per cent
Prestige of normal physique	value 10 per cent
Total	100 per cent

In making an estimate of the extent of disability the percentage of loss of each functional factor is conceived from the standpoint of medical knowledge and the result is expressed in terms of disability.

For instance, if it is thought the activity factor will be affected 25 per cent, then 25 per cent of 10, the value of the factor means 2 1/2 per cent disability. Applying the test to each of the factors in the 100 per cent scale on the so-called measuring rod of function and summing up the percentage of loss of each factor the total amount of disability is determined. For example, a back disability might be conceived as illustrated in Figure 3.

If a disability to an arm has occurred, such as a limitation of motion at the elbow the same principles, on the measuring rod, are applied. For example, an estimate might be applied as in Figure 4.

Multiple disabilities often are very troublesome in that the physician may be asked what percentage each contributes to a disability. These may be estimated as illustrated in Figure 4.

Another troublesome phase of estimating disability is that in which each individual disability to a part is so great that the sum of all disability percentages would be more than 100 per cent. The methods of calculating such a case is illustrated in Figure 6.

In many States the law awards a certain amount for loss of individual parts of the body such as a finger, hand, arm or foot. Where a disability has occurred to several parts of an extremity as in the finger, hand, and upper arm, it is sometimes rather difficult to express in proper percentage the disability each part is to the entire arm. The method of estimating such disabilities is illustrated in Figure 7.

TRIVIAL INDUSTRIAL INJURIES OF THE HAND LEADING TO PROLONGED DISABILITY

ALLEN B. KANAUEL, M.D. CHICAGO

IT is unfortunate that many patients with trivial injuries do not apply at once to their physician for proper treatment. Too often the surgeon sees patients who have sustained simple injuries of the hand which if they had been treated promptly and properly would have given rise to no disability or trouble. Many patients who now have useless hands would have been spared this disability had small pin and needle punctures, scratches, and bruises been properly treated, if such injuries had been properly cleansed and treated with antiseptics and kept clean.

Among these, attention may be drawn to infection from cattle hairs. These occur most commonly in those dealing with cattle, such as stockmen, those milking cows, etc. The hairs of cattle have scales that tend to migrate under the skin when they have entered through some cracked callus. These patients develop minor abscesses which, if opened, heal to be followed by repeated abscesses and disability often extending over a period of months. If the abscesses are

properly opened and all the migrating hair removed there is prompt recovery.

Another minor injury almost always neglected is that due to indelible pencils. For example, an office worker breaks off the point of an indelible pencil in the palm, the point remaining in the tissue. At times nothing is done, and at other times inadequate attempts are made at removal, with the result that the indelible lead is crushed. After this, although no difficulty may be experienced for several days, chemical action of the dye may take place and cause the death of the tissues around the pencil point puncture and infection may ensue. Such patients may have serious disability lasting for weeks and months and suffer great pain and discomfort. If a surgeon had been consulted he would have removed at once and completely the destructive indelible point. In the public schools in Germany indelible pencils are now forbidden to children, to safeguard them against the loss of eyes from injury of the conjunctiva from such pencils.

THE PROBLEM OF COMPETITION IN INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

H. J. WHITACRE, M.D., TACOMA WASHINGTON

THE time-honored and highly commendable ambition of every educated physician to develop a practice upon a basis of his opportunity to use his assets in service to society has been seriously thwarted in the state of Washington. This has been brought about by that form of health insurance known as contract practice.

Industrial accident insurance was first established in Washington to make it possible to render proper medical and surgical service to the workers in remote lumbering camps. Later this plan for paying for such service was adopted in cities and towns. Contract practice likewise followed this plan into the urban communities with the result that in the concentration of such surgery in the hands of a few physicians who seek these contracts the methods of securing this work are not always within the bounds of fair and ethical competition.

The medical profession did not resent industrial insurance or contract practice seriously as long as contracts were confined to industry and large groups of workmen. The object is to the employment of lay solicitors to comb the community extol their employers and sign up small groups in all walks of life. One such contracting physician is operating this system over a radius of 30 miles and this area includes large cities.

A commendable and necessary method of rendering medical care in remote industrial regions has been transformed by commercial methods into a gigantic health insurance movement that threatens to include the entire population, and the general medical profession is very properly alarmed.

Some have advocated the expulsion of contract doctors from our medical societies. Others have urged the passage of laws forbidding contract practice. Neither position is tenable.

Counter movements initiated by groups in medical societies have not always been successful for obvious reasons.

Eighteen months ago the physicians of Tacoma established a research laboratory for the study of medical economics, and industrial medicine in its relationship to the general problem of state

health insurance has been the major problem studied.

Contract practice is legal in the State of Washington.

Organized labor is opposed to contract practice and most of our physicians even those who hold contracts do not like this method of practicing medicine but both the preference of employers for this system, and the need of industry for some form of accident and health insurance have woven it firmly into the industrial fabric of the State of Washington. We must deal with it. We are not opposed to health insurance as a principle.

We are opposed to the evils which have crept in as the details of the system have been applied and believe that the medical profession should furnish the leadership for a movement to develop a better form.

The Tacoma group have done some intensive work on a plan for handling the situation in Tacoma. The causes of failure in other groups have been largely professional shortcomings and the entire group has now agreed to submit to rigid rules and regulations for their elimination.

We have tightened control by giving autocratic power to a committee of three. Each new case must be promptly reported to the office of the bureau, a case record must be set up, and the executive committee must review the file daily. This committee has the authority to call a consultation on any serious or prolonged case and the consultant must file a written report of the consultation at the bureau office. Bills may be modified or disallowed. State and insurance reports are sent through the bureau office and it is the duty of the manager to see that they are promptly and properly completed. The bureau or in other words the organized profession stands behind the quality of service rendered.

An experiment in a department store has shown that one dollar per month per person is not sufficient to render adequate medical service. The amount necessary is from one dollar and fifty cents to two dollars per month.

On the whole the plan of the Tacoma group is working well under the strict regulations.

CONFERENCE ON TEACHING OF SURGERY

GRADUATE AND UNDERGRADUATE TEACHING

THE personnel of the Committee on the Teaching of Surgery and Surgical Specialties is as follows: Fred C. Zapffe, Chicago, chairman; Elliott C. Cutler, Cleveland; Irving S. Cutter, Chicago; George J. Hauer, New York; Alexander R. Munroe, Edmonton; Allen O. Whipple, New York. The conference on this subject was held at the Jefferson Hotel, St. Louis, October 19, 1932, as a part of the Clinical Congress of the American College of Surgeons. Dr. C. Gordon Hayd, New York, vice-president of the American College of Surgeons, presided.

FRA KLIN H. MARTIN, director general of the American College of Surgeons, explained the reasons for the active interest of the College in the subject of teaching of surgery and the surgical specialties in the following terms:

Why does the American College of Surgeons seek co-operation with the Association of American Medical Colleges? Because it is a paramount aim of the American College of Surgeons to improve surgery that is necessary and to eliminate unnecessary surgery. If this program is to achieve its greatest development the American College of Surgeons must have an interest in every branch of medicine. It must co-operate with the approved medical schools where medicine is taught; it must co-operate with the approved hospitals, the environment in which doctors and surgeons treat the ill and injured; it must co-operate with the scientific development of general, special, and applied science and it must co-operate with the public on the basis of the ideals and ethics of the most learned profession.

There are in the United States about 145,000 registered scientific physicians. Approximately one-fourth of this number are engaged in public health activities, and another one-fourth have retired and are not now engaged in the active, independent practice of medicine. This leaves a total of some 73,000 doctors who are practicing independent preventive and curative medicine in personal health. It is therefore apparent that the American College of Surgeons—consisting of 10,849 practicing surgeons joined in a strong administrative corporation—is in a position to co-operate closely with your influential body that is so deeply interested in the guidance of the teaching of all branches of medicine and surgery.

Particularly are we interested that the scientific medical profession shall maintain the purity of its ranks—that it shall be kept free from the encroachments of irregulars, cultists, and patent medicine vendors.

We are anxious that medical graduates who are serving as interns in our hospitals shall be protected from the subtleties of politics and irregular associations—that any hospital shall be ineligible for intern assignments if it is loose in its ethics. If it tolerates irregular financial practices among its medical staff. If the staff conferences are neglected or actually repudiated and ignored, and if indifferent records and perfunctory laboratory reports are countenanced.

The College has worked conscientiously to eliminate these irregularities from hospital conduct. Each year the approved list of hospitals embodies such institutions as are found eligible after careful personal survey by a representative of the College. This list is in your hands. The dean of every Class A medical school possesses that record, and he can readily ascertain from us why any particular hospital is not on that list. If we can be shown that we have erred in our judgment in eliminating a hospital, we will be glad to make amends.

The paramount object of this yearly conference is to encourage a discussion of our mutual activities, and to lead the sympathetic influence and co-operation of the American College of Surgeons to the word of your Board, and to the medical schools which have the responsibility of educating the doctors of the future.

FRED C. ZAPFFE as chairman of the Committee spoke of the formation of the Committee and its purposes and stated that the Committee wished to secure the opinions of all teachers of surgery and to present them in a report which will be helpful to teachers of surgery in rebuilding their courses.

GEORGE J. HAUER's paper on "Graduate Teaching of Surgery" was presented, in his absence, by Dr. Zapffe. Dr. Hauer expressed the opinion that the opportunities for graduate instruction in surgery in this country are inadequate and that they could and should be increased, not only in the medical schools but possibly in the larger and more important hospitals. Dr. Hauer had sent out a questionnaire and analyzed the type of graduate teaching in 24 medical schools. In these schools graduate teaching in surgery takes the form of resident or fellow-ship systems, with a variable time in continuous residence in a teaching hospital where the experience includes surgical pathology, surgical diagnosis, pre-operative and postoperative course of surgical patients and a variable amount of operative experience gained at first as an assistant, then as an operator under supervision, and finally as an independent surgeon. These courses of instruction vary from 1

to 5 years and are not uniform in amount of time devoted to the various subjects or in the subjects covered. A number of the schools giving such courses grant degrees upon their satisfactory completion. Of the men who have taken such courses the majority have positions of professional or other rank in the country. The favorable opinion of the heads of the departments of surgery in certain medical schools toward such a course of instruction was expressed.

ELLIOTT C. CUTLER's paper on Undergraduate Teaching of Surgery was presented by Dr Zapffe. As a result of the questionnaire sent to leading surgeons teaching surgery in the United States the trend of opinion was expressed as being that these surgeons emphasized the type of the principles of surgery surgical pathology a course of minor trauma and sepsis and surgical diagnosis. These same men have indicated strongly that they do not think it within their province to teach operative surgery. Dr Cutler emphasized the desirability of realization on the part of the medical schools and licensing boards for the necessity of an extra and special training before medical graduates are allowed to assume responsibilities attendant upon the individual practice of surgery.

ALEX O. WHIPPLE presented his paper on Post Graduate Instruction in Surgery. Dr Whipple stated that the successful development in the organization of adequate and modern medical service in any community depends upon the training the ability and the experience of the professional personnel. The proper allotment of time and the graded sequence of the periods of training required in the various fields of medicine and the specialties are the factors which have to be considered in the pre medical school, medical school hospital in ternship residentship or fellowship up to and including post graduate courses for those already trained in general medicine or the specialties. These are but phases of the entire scheme of medical and

surgical training. Dr Whipple emphasized the fact that post-graduate courses in surgery and surgical specialties should be limited to candidates with adequate surgical training and with some experience in surgical practice. Such courses should be properly organized and conducted by senior and more experienced surgeons preferably under university auspices. In such courses the advantages were pointed out of diagnostic clinics follow up clinics, laboratory courses courses in roentgen film and fluoroscopic interpretation, courses in endoscopy and experience gained by close association with the teaching surgeons.

ALEXANDER R. MUNROE presented the 'Amendment to the Medical Profession Act of the Province of Alberta of 1926' which prescribes qualifications for those who practice surgery in that Province. The qualifications are fulfilled under the auspices of the Senate of the Provincial University. During the past 6 years, 83 certificates in general surgery and surgical specialties have been granted.

The discussion of these subjects was continued by Drs Howard C. Naffziger Samuel C. Harvey Owen H. Wangenstein George W. Crile, and W. T. Coughlin. Dr Harvey drew attention to the necessity of producing men with initiative enough to go on learning surgery the rest of their lives and to the fact that to accomplish this a modern system of apprentice assistants would be a desirable method. Dr Wangenstein expressed the opinion that so many already trained surgeons are now generally available that the minimal requirements of training for the practice of surgery should be clearly defined and he emphasized the importance in surgical training of experience in other than operative procedures. Dr Crile explained that all of the activities of the American College of Surgeons are part of a great educational program and indicated that it was fitting that such an institution display a great interest in the facilities available for the training of surgeons and surgical specialists.

COMMITTEE AND DEPARTMENT REPORTS

DEPARTMENT OF CLINICAL RESEARCH—ALBERT J OCHSNER MEMORIAL

THE work in clinical research, which is being conducted by the College includes that of the following committees: committee on the treatment of malignant diseases; committee on the archives of malignant diseases; committee on bone sarcoma; committee on the treatment of fractures; committee

on clinical laboratories; board on medical motion pictures; board on industrial medicine and traumatic surgery.

A survey of the work of this department which has been performed during the past year is embodied in the reports of the individual committees.

COMMITTEE ON THE TREATMENT OF MALIGNANT DISEASES

ROBERT B GREENOUGH M.D. Boston Chairman

I HAVE the honor to submit the following report of the Committee on the Treatment of Malignant Diseases.

The subject of cancer clinics has been actively promulgated during the past year by personal interviews with the administrators and medical staffs of hospitals. For this purpose the Director General has assigned the co-operation of the hospital investigators and in addition two special field representatives.

It is obvious that there are hospitals on the approved list of the College in which it would be inappropriate to have cancer clinics, such as in many of the hospitals of the federal government, in the hospitals for children, and in maternity, orthopedic, tuberculosis, mental, convalescent, contagious diseases, industrial, and eye, ear, nose and throat hospitals. But in every hospital into which cancer cases are received there should be facilities and personnel for efficient diagnostic and therapeutic measures, and this implies consultations or conferences between trained surgeons, radiologists, and pathologists.

In some hospitals it happens that there is one individual member of the staff or one department whose special interest in cancer has led to an unusually good organization for the cure and follow up of cancer cases in that department. Such hospitals are recognized in the Listing of the College by a special designation referring to the departmentalization of the hospital and the existence in one or more of the departments of the equivalent of the minimum standard for cancer clinics.

From other hospitals or clinics evidence has been presented to the College that the required facilities and personnel are available but that completion of the organization of a formal clinic along the lines

recommended by the College has not yet been accomplished. Such institutions will have appropriate recognition in the Listing of the College.

In certain clinics in medical schools, and in certain rural hospitals, the fraction of the cancer clinic is restricted to that of providing diagnoses, whereas the therapeutic measures are carried out in completely equipped institutions to which the patients may be referred. Such diagnostic clinics should attain appropriate standards and will receive recognition in the Listing of the College.

It is proposed that a list of approved cancer clinics be published in 1933. The hospitals that have been personally surveyed or from which adequate reports have been received during the past year number one thousand fifteen. Of these seven hundred two have no cancer clinics. A tentative classification of the cancer clinics follows:

Approved	190
Recommended	51
Organizing or contemplated	151

At the meeting of the Committee one year ago eleven additional record forms for cancer of different parts of the body were approved and extensive circulation has been given to these record forms which now number sixteen. During the year two new record forms have been prepared and others are in the course of preparation. The widespread adoption of these forms will do much to facilitate the compilation of reliable statistics on the subject of cancer in America.

In continuance of the previous work of the Committee, all Fellows of the College and Members of the Radiological Society of North America were invited during the month of May to register with the Committee all cases of cancer occurring in

their practice during the years 1924-25-26. As a direct response to this request there have been received thus far 2,365 detailed records of cancer of different parts of the body, included among which are 1,020 of 5 year survivals. These records are being subjected to careful analysis for grouping as to organs types of cancer methods of treatment and results, and the information will be tabulated and published with the three thousand detailed records previously in the archives of the Committee.

The recency of any general movement for the organization of formal cancer clinics and their more accurate records has impeded the work of the Committee in the collection of statistics of greater volume.

An important result of this widespread request and the distribution of record forms has been the known installation of improved record systems by many hospitals so that in the future compilation of results will be much facilitated. Many who signified their willingness to co-operate in this study found it impossible on account of incompleteness of their existing records, and have now installed new record systems.

The College engages in these cumulative studies for the benefit of its Fellows and of humanity and it will accomplish its purpose only when its Fellowship in its entirety approves and participates in such studies. These studies by the committees and by the administrative officers constitute merely a means of expressing the voice and work of the Fellowship of the College. On the other hand it is the duty of the committees and the administrative branch of the College to indicate to its Fellows methods and studies that will lead to progress in knowledge and in its application. In no small degree this purpose has been accomplished by the inauguration of the work directed toward the compilation of reliable statistics.

In addition to this work more attention has been directed toward the compilation of cumulative statistics from authenticated recent reports in the literature. Based on a study of this literature which has been compiled by the College Dr. Grantley W. Taylor prepared an article on Cancer of the Breast which was published by the College. Similar publications on cancer of other organs are contemplated.

Minimum Standard for Cancer Clinics in General Hospitals

1. **Organization** There shall be a definite organization of the service and it shall include an executive officer and representatives of all the departments of the hospital which are concerned in the

diagnosis and treatment of cancer. The services of a secretary and of a social service worker shall be available.

2. **Conferences** As an essential feature of the service there shall be regular conferences or consultations at which the diagnosis and treatment of the individual cases are discussed by all members of the clinic who are concerned with the case.
3. **Patients** Reference to the cancer clinic of all patients in whom the diagnosis or treatment of cancer is to be considered shall be either voluntary or obligatory in accordance with the vote of the medical staff or of the governing board of the hospital.
4. **Equipment** In addition to the diagnostic and therapeutic surgical equipment which is required in every approved general hospital there shall be available an apparatus for X ray therapy of an effectiveness which is generally agreed upon as adequate and an amount of radium sufficient to insure effective treatment.
5. **Records** In addition to the records which are required in every approved general hospital, there shall be additional records of (1) the details of the history and of the examination for cancer in different regions of the body, such as are indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases American College of Surgeons (2) the details of the treatment by radium or X ray as indicated on the form records which are recommended by the Committee on the Treatment of Malignant Diseases American College of Surgeons (3) periodic examinations at intervals for a period of at least five years following treatment.
6. **Treatment** The treatment of cancer patients shall be entrusted to the members of the staff of the cancer clinic except in cases in which adequate treatment in accordance with the collective recommendation of the staff of the cancer clinic can be procured otherwise.

The personnel of the Committee on the Treatment of Malignant Diseases is as follows:

Robert B. Greenough, Boston <i>Chairman</i>	
A. C. Broders, Rochester Minn.	John M. T. Finney Baltimore
Curtis F. Burnam Baltimore	Burton J. Lee New York
George W. Crile Cleveland	Frank W. Lynch, San Francisco
Bowman C. Crowell, Chicago	Robert T. Miller Jr. Baltimore
William Duane, Boston	Henry K. Hancock, Philadelphia
Edwin C. Ernst, St. Louis	H. Gideon Wells, Chicago
Rupert H. Fike Atlanta	Francis C. Wood, New York

COMMITTEE ON THE TREATMENT OF FRACTURES

CHARLES L. SCUDDER, M.D. Boston Chairman

I HAVE the honor to submit to the Board of Regents the ninth annual report of the Committee on the Treatment of Fractures. There are now 39 members of the General Committee.

The death of a former member of the committee, Dr. A. P. C. Ashhurst of Philadelphia and the death of an active member, Dr. Nathaniel Allison of Chicago are recorded.

A revised and amplified second edition of *An Outline of the Treatment of Fractures* has recently been published by the College. The cordial reception of the first edition of this *Outline* by the profession has more than warranted the time and expense spent in completing this second edition. To Dr. Roscoe Webb of Minneapolis, Dr. Edwin Ryerson of Chicago and the director of the Department of Clinical Research, Dr. Bowman C. Crowell, the appreciation of this Committee is extended for their supervision and conduct of this second edition. The Committee hopes to keep this *Outline* abreast of any important advance in the treatment of fractures. New printings from time to time will be made. It is the desire of the Committee to keep those members of the American College of Surgeons who are especially interested in fracture treatment periodically informed of progress in this special department of surgery. Copies of this *Outline* may be had by addressing the American College of Surgeons, 40 East Erie Street, Chicago, Illinois.

Regional committees. It has been from the beginning and still is the policy of the General Committee to extend the influence of the College through the living personal contacts made by membership of surgeons interested in fractures in these regional groups. There are now twenty-eight such Regional Committees. We have, therefore, at present about three hundred men carrying the ideals of the College directly into their several committees. The Committee believes that an immediate formation of new committees should be undertaken. Each state should have one or more active regional groups. Many applications have been received from different parts of the country for the formation of these local committees.

Industry is demanding that which the Committee on the Treatment of Fractures is prepared to deliver. It is strongly urged that the Department of Clinical Research make an immediate response to this demand.

In order to facilitate the work of these regional groups the College will soon publish in mimeographed form the reported activities of all existing regional committees.

Sub-committees. Steel Bone Plates and Screws. Committee: Philip D. Wilson, W. O'Neill, Sherman Norman, T. Kirk, Wm. L. Keller. On June 18, 1931, a general conference of representative manufac-

turers, distributors, and users of steel bone plates and screws adopted a commercial standard for this commodity. The industry here has since accepted and approved for promulgation by the Department of Commerce through the Bureau of Standards, the commercial standard. The standard became effective for new production on November 16, 1931.

The general conference voted the establishment of a standing committee. Dr. P. D. Wilson, chairman, sub-committee: American College of Surgeons, Dr. J. F. Barry, Veterans Administration, Dr. J. F. Cochrane, Kny Scherer Corporation, Captain E. J. Gow, Navy Department, Major N. T. Kirk, Walter Reed Hospital, Harvey R. Pierce, Harvey R. Pierce Company, Charles J. Pilling, Gen. P. Pilling & Sons Company, John M. Smith, American Hospital Association, F. W. Reynolds, secretary, Bureau of Standards.

The normal interval for revision of the standard is set for one year. Acceptances of the standard established were received from associations, firms, hospitals, and surgeons, and from government departments. The door to progress remains open through the existence of the permanent committee.

The Sub-Committee on Medical Education. Wm. Darrach, Frederic J. Tees, Isidore Cohn, George A. Leland, Jr. and Clay Ray Murray. Most of the medical schools of the country have reduced the number of hours in their undergraduate curriculum. As a result, in many special fields of medical work, the undergraduate instruction has become of necessity limited very largely to a thorough understanding of general principles followed by an opportunity to apply these to individual cases under the direction of a teacher. As a result of this, it has become of increasing importance that those responsible for the undergraduate teaching of fractures should concentrate their efforts on formulation and explanation of broad general principles. To make up for the lack of undergraduate teaching it is of great importance that in each hospital at least one be made responsible for the careful training of an intern staff in this field. Moreover, the need for the establishment of opportunities for the practicing physician to refresh or increase his knowledge in the treatment of fractures has become much greater. It is therefore recommended that:

1. Even greater stress be placed on instruction in the pathology of fractures, the process of repair and the broad general fundamental principles of treatment.

2. Each hospital, whether it contains a special fracture service or not, appoint someone who shall be responsible for the training of internes in the treatment of fractures.

3. Wherever possible opportunities for continued education for graduates in medicine be established.

both in teaching hospitals and under the auspices of the various medical societies.

The sub-committee reported in detail the methods in use at Columbia University in teaching the treatment of fractures to undergraduates. Graduate teaching is also being handled by this committee.

The sub-committee is in touch with the several groups interested in medical education in the United States especially the Council on Medical Education of the American Medical Association, The Association of American Medical Colleges, the Commission on Medical Education, and the Committee on the Teaching of Surgery of the American College of Surgeons. It is hoped that a further consideration of undergraduate instruction in fracture treatment may be secured.

The sub-committee has communicated with those bodies having in charge the examinations of graduates of medical schools for licensure to practice medicine. It has been thought that the Educational Committee might propose to these bodies the National Board of Medical Examiners, and through this group to the various state examining boards the general scope of questions to be asked the recent graduates of medical schools so that pressure may thus be brought to bear in a perfectly legitimate fashion upon the undergraduate school to produce well informed graduates in these fracture matters. These groups are vitally interested in similar problems.

A letter was sent to the National Board of Medical Examiners asking if they would accept suggestions regarding questions on fractures which the National Board would ask. A favorable reply came from the Board desiring to co-operate with this committee. The Federation of State Medical Boards is associated with the National Board of Medical Examiners. A letter from the secretary in Des Moines states that they are in full agreement.

The Sub-Committee on Physical Therapy. Fred Eric J. Cotton, H. Earle Conwell, Clay Ray Murray. This committee is preparing a carefully edited statement of the status of physical therapy in the care of fractures.

The Sub-Committee on the American Railway Association. The Permanent Committee on Fractures of the Medical and Surgical Section of the American Railway Association made a very constructive report at the May 1932 meeting in New York. This covered (1) first aid instruction to employees of railway companies (2) co-operation with the Fracture Committee of the American College of Surgeons in the matter of improving the treatment of fractures—in the adoption of 'An Outline of Treatment' when published (3) X ray reports as practiced by one of the members, R. C. Webb, chief surgeon of the Great Northern Railway. The X ray suggestions were the same as those in 'An Outline of Treatment' recently published.

Addresses were made by Mr. E. H. Kimball, claims attorney for the Great Northern Railway

editor of the *Bulletin of the Association of Railway Claim Agents* also Mr. Winter, claim department of the Chicago Northwestern Railroad. The Association of American Railway Claim Agents will soon co-operate formally by appointing a committee.

The Sub Committee on Ambulance Equipment and First Aid. Robert H. Kennedy, chairman. Philip H. Kreuscher, W. L. Keller, Hubley Owen. This committee has reported a definite program which is being carried out and it is hoped will extend to every center in the United States. The move has already begun in New York City and has extended to Philadelphia. Throughout the west funeral homes and undertakers provide the ambulance service for doctors. Relations have been established with the National Association of Funeral Directors and it is hoped that they will consider the idea of equipping ambulances and instructing the drivers of ambulances along the lines formulated by the committee.

The Sub-Committee on American Red Cross. The committee has completed its contribution to the first aid work of the *American Red Cross Manual*. This *Manual* is now being printed and a new edition is soon to appear containing these suggestions. The committee is thus in touch with the many first aid classes of the American Red Cross throughout the United States.

The annual Fracture Oration last year was given by Dr. Wm. Darrach, professor of clinical surgery, of Columbia University. This year the Oration is to be given by Dr. Philip D. Wilson of Harvard University.

The committee is active in furthering in every way possible a better treatment of fractures.

Standard for Minimum Equipment for Fracture Treatment in Hospitals

- 1 That all general hospitals be equipped to care for fractures that the minimum equipment for the transportation and emergency treatment of fractures be the following or its equivalent.

Thomas upper extremity splints. Thomas lower extremity splints with traction straps, slings and buckle straps, Hodgen splints, coaptation splints, assorted sizes. Cabot wire splints straight pieces of wood (of assorted length, width and thickness) for splints. Plaster of Paris bandages some form of overhead frame for suspension. Suitable X ray apparatus, including a portable machine if practicable.

- 2 That it is highly desirable that one individual surgeon be responsible for the supervision of the care of fractures in each hospital service.
- 3 That special record sheets be used for fracture cases.
- 4 That a close follow up be maintained on all fracture cases for such time as necessary to establish an accurate knowledge of end results.

The personnel of the Committee on the Treatment of Fractures is as follows

Charles L. Scudder, Boston, *Chairman*
Frederic W. Bancroft, New York, *Secretary*

Willis C. Campbell,
Memphis
Isidore Cohn,
New Orleans
H. Earle Corwell,
Birmingham
Salvador Cordoba,
Venezuela
Frederic J. Cotton,
Boston
William R. Cribbins,
Chicago
William Darrach,
New York

Frank D. Dickson,
Kansas City, Mo.
Eldridge L. Eliason,
Philadelphia
William L. Estes,
Bethlehem
W. Edward Galle,
Toronto
Fraser B. Gard, Montreal
Donald Guthrie, Sayre
George W. Hawley,
Bridgeport
Melvin Henderson,
Rochester, Minn.

William L. Keller,
Washington
Robert H. Kennedy,
New York
Norman T. Kirk,
Washington
Phillip H. Kretschmer,
Chicago
Walter Estell Lee,
Philadelphia
George A. Letland, Jr.
Boston
Paul B. Magnusson,
Chicago
Clay Ray Murray,
New York
Lloyd Noland,
Birmingham
Hubley R. Owen,
Philadelphia

Dallas B. Phemister,
Chicago
Edwin W. Ryan, Jr.,
Chicago
W. O'Neill Sherman,
Pittsburgh
Ernst A. Sommer,
Portland
Killogg Speed, Chicago
Frederick J. Tees,
Montreal
Jorge del Toro, Porto Rico
John B. Walker, New York
Wesley C. Webb,
Minneapolis
George E. Wilson,
Toronto
John C. Wilson,
Los Angeles
Phillip D. Whelan, Boston

BOARD ON INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

FREDERIC A. RESLEY, M.D. WAUKEGAN, ILLINOIS, *Chairman*

THIS year we have to report that through the direction of Dr. Franklin H. Martin, the Director General the scope of the activities of this Board has been broadened and expanded in the field of medicine and surgery in industry. Dr. Williamson and Dr. Newquist have continued their contacts with large industrialists in their first hand fact finding surveys.

The following is a summary of Dr. Williamson's report.

SCOPE OF MEDICAL SERVICE

Only a small percentage of industries included in my survey extend medical treatment beyond the care of injuries and emergent and minor illness arising during working hours. Except for the hospitalization of major accidents and compensable cases requiring operating-room service and institutional care, the treatment of employees is generally restricted to that which can be rendered in the plant dispensary. It was found that 330 plants out of the 375 visited maintained a dispensary with facilities sufficient to supply the above service. The results of our studies show further that 221 (64.3 per cent) of the industries provide pre-employment physical examinations, while 115 (30.6 per cent) have periodic examinations of all or certain groups of workers, 290 companies (77.3 per cent) have some form of benefit plan in operation such as (1) mutual aid association maintained by the employees alone or on a contributory basis. The benefits are weekly cash allowances for a stated period payable for loss of time due to illness and non-compensable injuries. Only a small percentage of these associations provide the doctor's services. (2) Relief plan maintained by the company (3) Group insurance plan which

provides benefits for total disability and death, and in a small number of cases an allowance is provided also for illness and non industrial injuries.

In conclusion, I would recommend that out of the 375 industries surveyed, 178 (45.8 per cent) be placed on the approved list that 158 (41.9 per cent) be not approved and that 45 (12 per cent) be conditionally approved pending the receipt of additional information.

Attention is again drawn to the fact that this report is confined to a survey of industries with 500 or more employees and the findings and the figures are not compared with medical conditions that exist in smaller industries.

The following is a summary of Dr. Newquist's report.

Since a Minimum Standard to insure adequate medical care has been adopted by the College it is the yard stick by which we measure such industrial medical service for subsequent rating or approval by the College.

Statistical data—

Number of industries surveyed	146
Number of employees per industry ranged from 250 to 120,000—	
average	4,317
Total number of employees involved	1,065,000
Total number of employees having payroll deductions for complete medical and hospital service	
374,545 or 36 per cent	
Total number of employees having payroll deductions to include medical service for families	65,000 or 6 per cent

Types of compensation insurance—

	Industries	Per cent
Self insured	16	51
Indemnity company	0	3
State compensation fund	50	20

Physicians—

Full time	101	41
Part time	46	34
On call	1	6
None designated	4	19

Dispensary facilities provided by industry

223 90

Pre-employment physical examinations in industry

14 0

Group insurance

10 69

Recommended for full approval by the College

135 55

Recommended for conditional approval by the College

1 6

Recommended for no approval by the College

94 39

We wish to emphasize the fact that the 36 per cent of employees in the industries we have surveyed who are served medically on a group insurance basis does not quite represent a true picture of the present situation in industry. We have not visited the

smaller industries where such conditions are not so prevalent. Further a complete and comprehensive survey has been made by Dr. Newquist of the Medical and Surgical situation in the state of West Virginia as it relates to the Workmen's Compensation Law and the State Institutions. This survey was requested and financed by the State Medical Society. His exhaustive report will be published in full.

On Friday afternoon, October 21, 1933, a meeting was held in St. Louis, the program being devoted to scientific discussion on medicine and surgery in industry.

The personnel of the Board on Industrial Medicine and Traumatic Surgery is as follows:

Frederic A. Besley, Chairman
Bowman C. Crowell, Secretary

John E. Bacon,	Thomas G. Orr
Miami, Arizona	Kansas City
Samuel R. Cunningham	W. O'Neill Sherman,
Oklahoma City	Pittsburgh
Donald Guthrie Sayre	Loyal A. Shoudy
Lucian H. Landry	Bethlehem
New Orleans	Ernst A. Sommer
A. D. Lazenby, Baltimore	Portland
Charles F. Martin,	Frederick J. Tees,
Montreal	Montreal
Charles H. Mayo	John B. Walker
Rochester, Minn.	New York

REGISTRY OF BONE SARCOMA

BOWMAN C. CROWELL, M.D. CHICAGO Registrar

I HAVE the honor to submit the following report on the Registry of Bone Sarcoma.

During the year records of two hundred two cases of bone sarcoma have been submitted to the Registry and the most of these will be registered. In a few only is the information submitted to the Registry insufficient to justify registration. Five hundred eighty-one of the case records have been circulated and studied by thirty-four different individuals whose names appear on the classification sheets of the individual cases. Selected groups of cases have been issued upon request for educational purposes. The total number of cases in the Registry is now fourteen hundred four and they are classified as shown in accompanying table.

This year there have been eight additional cases of osteogenic sarcoma which have completed their 5 year survival period without recurrence of the tumor. Added to our previous figures this gives 59 in a total of 389 cases of osteogenic sarcoma living 5 years or more following treatment that is to say that the Committee unanimously agrees upon these 59 cases as being osteogenic sarcoma. There has been no meeting of the committee as a whole this year.

During the absence of the registrar on account of illness the scientific work of the registrar was carried on by Dr. Joseph J. Lebowitz and Dr. R. Bruce Malcolm to whom much credit is due for the manner in which they conducted the work. Detailed statistics are being prepared.

Osteogenic sarcoma

Of the femur	289
Other than the femur	366
Ewing's sarcoma	156
Myeloma	53
Lymphosarcoma	6
Inflammation	69
Periosteal fibrosarcoma	24
Metastatic tumor	37
Angioma	9
Hemangio-endothelioma	10
Benign giant cell tumor	272
Giant cell tumor malignant	14
Benign osteogenic tumor	37
Unclassified and miscellaneous	46
Not bone tumors	16

MEDICAL MOTION PICTURE FILMS

J. BENTLEY SUTHER, M.D., NEW YORK, Chairman

THE importance of motion pictures as a means of disseminating medical knowledge has been generally accepted by the profession, and there is an ever increasing interest in the work done by the American College of Surgeons in connection with the Motion Picture Franchise and International American Film Exchanges. These are of great educational significance as evidenced by the annual distribution of recording medicine films.

The Board on Medical Motion Picture Films of the College consists of the following members: WILLIAM H. HARRIS, Esq., New York, Chairman; J. BENEDICT SMITH, M.D., New York, Secretary; JAMES E. TRENKLE, M.D., Fall River, Secretary; V. W. CHAMBERLAIN, M.D., New York, Financial; H. V. ALLEN, M.D., Chicago, Secretary; A. M. D. GLENN, Esq., Charles H. VANCE, M.D., Fall River, Secretary; C. CROWELL, M.D., Chicago, Secretary; and T. MACDONALD, M.D., Chicago.

The College is very anxious to encourage the use of medical motion pictures and to make it as easy as possible for the surgeon to obtain them. As the films are reviewed by the College, it is the policy of the College to make it as easy as possible for the surgeon to obtain them. The College is also interested in the question of what films are available and where they can be obtained. The College is also interested in the question of the cost of the films.

During the past few years my efforts have been made in recording methods and in procuring equipment that will be important factors in the production of talking films to the teaching of medicine and surgery. The Board on Medical Motion Picture Films is keenly interested in the development of this type of films and is maintaining close contact with the various organizations which are concerned with this phase of motion picture production and distribution of the films.

Very large audiences were present at all times at the numerous daily exhibitions of medical motion pictures which was one of the features of the Clinical Congress of the College in St. Louis. The 35 films used for these demonstrations included several new talking films with both sound-on-film and for recording.

Thirty-three reels of medical motion picture films have been approved by the American College of Surgeons and are available for distribution. Many additional films have been reviewed by the College, although they have not yet been formally approved. Our reviewing committees consider them to be an effective presentation of the subject matter and the procedures shown to be of interest and value.

Information pertaining to medical motion picture films may be obtained by communicating with the College.

THE LIBRARY AND DEPARTMENT OF LITERARY RESEARCH

THE Library of the College is the embodiment of the literary and scientific interests of the Fellows. The collection has grown steadily in the course of the past year through the addition of books and reprints written and presented by Fellows of the College. The reprints are supplied (preferably) in duplicate making possible the placing of one copy in the Fellow file where it is a record of the work of that Fellow and the second in the classified package library section where it is available for circulation. In addition to the contributions from the Fellows numerous friends of the College have presented copies of their works and from these sources the collection of current monographs has been augmented. Fellows and friends have likewise generously replied to the request for unbound journals and reprints and have notified the Library by letter or phone call when such material has been available so that it could be added to the collection already on file in the package library. Several members of the profession regularly keep in touch with the Library by this means.

Two collections are actively growing. The H. Winnett Orr collection of orthopedic works contains valuable historical material as well as later monographs and the Medical Women's Library including books and pictures, is made up of interesting material.

The co-operation of the many Fellows who have contributed toward the development of the Library is greatly appreciated. It is hoped however that the number of those actively interested in building up this collection may be increased during the coming year. The Library is a phase of the College work in which each individual should have a part. It is his privilege to see that his work is represented in that collection as an inspiration to future generations of surgeons, and it is to his interest to aid in the enlargement of its resources by assisting in the transfer of any available collections (whether they be large or small and whether of current or historical interest). At the present time the oldest volume in the College Library is dated 1555. Any Fellow who has a book of earlier date or any old monograph for which he wishes to find a permanent home may find

a suitable place for it in this collection. College bookplates are available upon request. Those in charge of the Library will be glad to co-operate in making the collection thoroughly representative of the activities and interests of every Fellow of the College.

DEPARTMENT OF LITERARY RESEARCH

In conjunction with the Library the Department of Literary Research has continued to render to Fellows of the College and members of the medical profession its three fold service including (1) package library material made up of reprints and clippings which are loaned free of charge (2) bibliographies compiled upon specific subjects at the request of the doctor and (3) abstracts and translations prepared in accordance with the instructions of the one submitting the request. During the past year, the Department has cared for the usual number of requests and the service has been even more prompt than in the past.

Taking into consideration the stringency of the times every effort has been made to keep the cost of each piece of work as low as is compatible with careful and accurate workmanship. Regardless of the present economic situation it must be recognized that translations to be of value must be carefully and accurately prepared. However in many cases the cost of the work can be reduced by the preparation of abstracts or summaries rather than complete translations and by the elimination of case reports and lengthy discussions of non-essential details. The familiarity of the College Research Staff with the medical literature in the various languages (German French Italian Spanish Swedish Dutch and Russian) is an additional factor in the economical preparation of the translations. Thus by wise administration and careful management those directing the Department have been and are using every possible means of keeping the cost of research within the reach of every Fellow of the College so that practical considerations will not interrupt the flow of valuable contributions to scientific progress from this great body of men.

ST LOUIS COMMITTEE ON ARRANGEMENTS

Evarts A. Graham, *Chairman*, F. A. Jostes, *Secretary*, Fred Bailey, Willard Bartlett, M. B. Clopton, William T. Coughlin, Clarence H. Crego Jr., L. W. Dean, Ellis Fischel, W. C. Gibson, William P. Glennon, Max Goldstein, John Green, H. A. Hanser, Roland Hill, Harvey J. Howard, Charles E. Hyndman, Walter Jones, R. Emmet Kane, W. C. G. Kurchner, W. E. Leighton, Curtis H. Lohr, William H. Luedde, McKim Marriott, Harvey S. McKay, H. G. Mudd, James Mudd, Max Miver, Louis Ransleur, Francis Reder, William E. Sauer, Otto Schwarz, Alphonse M. Schwitalla, Major Seelig, Omar R. Sevin, Carroll Smith, Max Starkloff, Ross Woolker, O. B. Ziemert.

SUB-COMMITTEES

Ophthalmology and Otorhinology
L. W. Dean, *Chairman*, Max Goldstein, John Green, Harvey J. Howard, William H. Luedde, William E. Sauer.

Community Health Meeting

Ellis Fischel, *Chairman*, Fred Bailey, Charles E. Hyndman, F. A. Jostes, Francis Reder, John Sutter.

Publicity

Major Seelig, *Chairman*.

OFFICERS ELECTED

President, William D. Haggard, Nashville.
Vice-Presidents, Evarts A. Graham, St. Louis; Alexander R. Munroe, Edmonton.

Regents for term expiring in 1935: Irvin Abell, Louisville; John R. Fraser, Montreal; Franklin H. Martin, Chicago; George P. Moller, Philadelphia; Richard R. Smith, Grand Rapids.

Members of the Board of Governors for term expiring in 1935: Fred H. Albee, New York; Edward W. Archibald, Montreal; Samuel C. Baldwin, Salt Lake City; Joseph C. Beck, Chicago; Frederic A. Beale, Waukegan, Illinois; William V. Blispham, Washington; Joseph C. Bloodgood, Baltimore; Frank K. Boland, Atlanta; Frank E. Burch, St. Paul; Henry T. Byford, Chicago; Walter W. Chipman, Montreal; Frederic J. Cotton, Boston; William L. Cousins, Portland; Melba A. J. Crowell, Charlotte; Thomas S. Cullen, Baltimore; Carl Henry Davis, Milwaukee; Edward P. Davis, Philadelphia; Lee Wallace Dean, St. Louis; Edward C. Ellett,

Memphis; George Gellborn, St. Louis; Oliver D. Hamlin, Oakland; Casper F. Hegner, Denver; George J. Heuer, New York; Gerrit R. Holden, Jacksonville; Edward J. Ill, Newark; Jabez N. Jackson, Kansas City; Missouri; John E. Jennings, Brooklyn; Burton J. Lee, New York; Southgate Leigh, Norfolk; Jennings C. Litzberg, Minneapolis; John Prentiss Lord, Omaha; William H. Luedde, St. Louis; John G. MacDougall, Halifax; William B. Owen, Louisville; Robert Lee Payne, Norfolk; Harold E. Ridewood, Victoria, B. C.; Hubert A. Royster, Raleigh; Arthur M. Shipley, Baltimore; Wells Ferrin Smith, Little Rock; George N. J. Sommer, Trenton; Frederic N. G. Starr, Toronto; Julia C. Strawn, Chicago; George W. Swift, Seattle; Howard C. Taylor, New York; Wallace I. Terry, San Francisco; Clarence G. Tuland, Los Angeles; Edgar A. Vander Veer, Albany; John B. Walker, New York; George Gray Ward, New York; Horace J. Whitacre, Tacoma.

HOSPITAL STANDARDIZATION

REPORT OF 1932 CONFERENCE IN ST LOUIS

An abstract of the papers and discussions presented at the Hospital Standardization Conference held during the Clinical Congress of the American College of Surgeons in St. Louis October 17-21, 1932 is presented in the following pages. Allen B. Kanavel, M.D., Chicago, past-president of the College, presided.

GREETINGS

Greetings were given by the president-elect, J. BENTLEY SOUTER, M.D., New York, who referred briefly to the Hospital Standardization movement and its accomplishments during the past 15 years.

OPENING ADDRESS

An appropriate address of welcome was made by CURTIS H. LOHR, M.D., St. Louis, in which he referred to the progress made in hospital service generally, mentioning particularly the substantial contribution of the American College of Surgeons through its hospital standardization movement. He announced that five of the city institutions under his jurisdiction were included this year in the list of approved hospitals published by the American College of Surgeons. In making the announcement, he said it would always be his purpose as hospital commissioner to keep all city institutions meeting the high standards. In reference to political tax-supported institutions, he was of the opinion that such conditions could be avoided if there existed between hospital managements and commissioners the understanding that service to the patient must always be the primary consideration. He appealed to those superintendents of tax-supported hospitals who would stick firmly to their convictions and carry out the best principles of Hospital Standardization regardless of political interference.

PRESENTATION OF THE FIFTEENTH ANNUAL REPORT OF HOSPITAL STANDARDIZATION

FRANKLIN H. MARTIN, M.D., Chicago, speaking in behalf of the American College of Surgeons of which this Hospital Conference is the guest, May 1, before presenting the annual report of our approved hospitals, say a few words regarding one or more acute problems.

The college has found no more dependable protection against fee-splitting than the influence of the staffs and superintendents of our approved hospitals. We must guard ourselves against the subtle commercialism of some of our own confreres. Every

hospital must safeguard its medical staff and the general practitioners by refusing to permit irregulars to practice in the institution. In dealing with a hospital that fails to protect the scientific profession against such invasion, the College has no alternative—it must remove the hospital from the approved list.

Hospitals and the medical profession are being embarrassed by the construction of many institutions by the government to care for disabled veterans of all wars. New hospitals are being built in face of the fact that there are several thousand general and community hospitals with well organized staffs in which these soldier patients could be properly cared for in their respective communities by their own doctors and at much less expense to the government than by the present program which involves huge expenditures.

Furthermore, it is alleged that from two-thirds to three-fourths of the patients in Veterans Administration hospitals are comprised of veterans suffering from diseases and disabilities in no way traceable to war service. In order to check this menace, we must act promptly. Letters and telegrams of protest should be sent at once to those who are responsible for this government ownership of our activities and to those who are in a position to remedy it.

In order to minimize the cost of hospitalization, several points of conduct should be watched: (a) extravagance in building, (b) inefficiency of service, (c) carelessness in segregating patients according to their ability to pay, (d) lack of provision for moderate priced rooms, (e) disproportionate laboratory, X-ray and other diagnostic accessories, and possible overcharge, (f) lack of discrimination in applying extras in accordance with individual needs, (g) indiscriminate supplying of food, (h) extravagant assignment of nurses, (i) excessive charges for operating room anesthetics, etc.

For 4 years the Hospital Department of the College has urged our approved hospitals to co-operate with the independent practitioners of medicine by offering the services of their institutions for diagnostic purposes through the establishing of health inventonums. Through furnishing its facilities for the thorough periodic health examinations of individuals by their own physicians, the hospital would become the meeting ground for all regular practitioners, and the haven of the community. It would solve the problems of all physicians and their patients in the conduct of diag-

postic service, and would insure to the hospital a friendly clientele of transcendent importance. It would aid in the establishment of tumor and cancer clinics, and emphasize also the importance of establishing special services for the early diagnosis of other preventable diseases.

Following is a summary of the results of the 1932 Hospital Standardization survey:

Hospitals of 20 beds and over	
Surveyed	575
Fully approved	418
Percentage fully approved	60.6
Conditionally approved	57
Percentage conditionally approved	3.3
Not approved	9
Percentage not approved	6.1
Total fully and conditionally approved	440
Total percentage fully and conditionally approved	63.9
2. Hospitals of 11-20 beds	
Surveyed	235
Fully approved	540
Percentage fully approved	33
Conditionally approved	60
Percentage conditionally approved	6.6
Not approved	5
Percentage not approved	5.4
Total fully and conditionally approved	144
Total percentage fully and conditionally approved	6.6
3. Hospitals of 1-10 beds	
Surveyed	824
Fully approved	127
Percentage fully approved	14
Conditionally approved	60
Percentage conditionally approved	5.8
Not approved	6
Percentage not approved	7.5
Total fully and conditionally approved	177
Total percentage fully and conditionally approved	20.5
4. Government hospitals	
(a) Army	
Surveyed	5
Fully approved	5
Percentage fully approved	100.0
(b) Navy	
Surveyed	16
Fully approved	16
Percentage fully approved	100.0
(c) Public Health Service	
Surveyed	35
Fully approved	35
Percentage fully approved	100.0
(d) Veterans Bureau	
Surveyed	70
Fully approved	70
Percentage fully approved	100.0

5. Other Countries

Twenty-eight hospitals of other countries have been awarded full approval, and are included in the List of Approved Hospitals for 1932.

SUMMARY

Total surveyed	3,474
Total fully approved	2,091
Total percentage fully approved	60.4
Total conditionally approved	200
Total percentage conditionally approved	5.8
Total not approved	1,170
Total percentage not approved	33.8
Total fully and conditionally approved	2,291
Total percentage fully and conditionally approved	
Hospitals 100 beds and over	93.9
Hospitals 50 beds and over	81.4
Hospitals 25 beds and over	67.1

THE STANDARDIZED HOSPITAL AS A MEDICAL EDUCATIONAL CENTER

ALLEN B. KANAVEL, M.D., Chicago. The standardized hospital offers the best means of providing a continued education for physicians and is a fertile source of information for the public. So that it may function most efficiently as a teaching center it is necessary however that there be a broader conception of the functions of the standardized hospital. The staffs of these institutions, both physicians and nurses, must divest their minds of the idea that they are founded solely to furnish medical service to the patient coming to their doors. The community hospital as well as the university hospital must become a teaching center.

In their plans for furthering the education of physicians the staffs of the standardized hospital should so organize their activities as to give systematic instruction to their internes, establish residencies for aspiring specialists, and provide adequate opportunities for the education of the general practitioner in the later developments of medicine. Instead of the *laissez faire* attitude toward interne instruction now so common in hospitals, the interne should be encouraged by organized effort to pursue the systematic reading of good medical literature, to carry on the intensive study of group cases, and to make reports of his clinical investigations to the assembled staff where free discussion by internes, residents, and the staff will clarify his knowledge. Periodic pathological conferences will arouse his interest and be of value to the whole medical group.

Every hospital should aspire to the establishing of residencies of 1, 2, or 3 years according to its size and opportunities. These residents may come from the interne body but it is to be hoped that here the physician who has been out in general practice may find the opportunity for perfecting himself in some special line. These aspiring specialists should be assigned to those particularly qualified to guide them in their reading and practice. They should be encouraged to carry on experimental and clinical studies, a by-product of which would be medical articles for publication but the greatest value would come to the resident through the development of his habits of observation, perfection of his critical analysis of disease, and particularly of his imagination.

The standardized hospital should be the center for the dissemination of new procedures and new knowledge to the practicing physician. We have all recognized our need of continued instruction and attempted to meet it by attending medical meetings and post graduate clinical weeks. The inadequacy of didactic teaching of this type is too well known to deserve comment. Of much more value would be instructional courses given in the standardized hospitals by qualified members of the profession not lectures but systematic laboratory courses and actual demonstrations of pathological material, chemical procedures, the treatment of emergencies, the recognition of uncommon conditions, and the treatment of the simpler diseased conditions coming within the realm of the specialist. So far as possible such courses should consist of actual work by the practitioner and be limited to a few participants.

Of equal importance is the systematic instruction of the community in the knowledge of the principles of scientific medicine. Addresses to the community upon practical subjects by the local profession under the auspices of the hospitals and sponsored by civic organizations such as churches, lodges, business men's organizations, women's clubs, etc. will arouse general interest. Such instruction might well include special group classes in domestic science, the preparation of diet in health and disease, simple nursing aids, care of expectant mothers, care of babies and the preparation of their foods, lectures upon contagious diseases, the recognition of emergencies, sexual hygiene and marital relationships.

The hospital should foster the health movement by providing facilities for the profession to carry on this work in a systematic manner at a nominal expense. Such public instruction will not only be of value to our people but will also attach to the hospitals the loyal support of our citizens and diminish the menace of quackery.

DISCUSSION

HORACE J. WHITAKER, M.D., Tacoma, Washington. Undoubtedly, adult education, or a continuation of education after the intensive study of college days, is one of the real problems of society. Whether this education concerns general problems or specialized fields. There is perhaps no social group that has done a better job of continuation study than the medical profession, as it is carried on through county, state, national, and specialized society meetings where advances in scientific medicine are discussed and general information advanced. The hospital of each community provides a very practical agency, however, which is not covered by any of the activities mentioned and has great potentialities for the increase of practical directly usable knowledge among physicians.

There need not be any conflict between the educational program of the hospital staff and that of the county medical society. The county medical society is the legitimate place for formal papers and organization work, while the program of the hospital

staff meeting is confined strictly to the presentation of specific cases in the hospital, demonstration of diagnostic methods, laboratory technique and autopsy findings.

The most important place for the development of a well organized educational program within a hospital is the community where there is no teaching institution. I represent such a community. We feel that the most important element in our hospital educational organization is a full time pathologist who has definite teaching ability. We hold regular monthly staff meetings, a weekly medical clinic, a weekly tumor clinic, regular meetings of an interne and an ex-interne group and a continuously operating anatomical dissection department. In all of these our full time pathologist is in a large measure the leader and to a considerable extent the hub of the wheel.

This arrangement prevents us from degenerating to the unprofitable routine of reporting successful cases and maintains a status of scientific alertness.

THE CHANGING RELATIONSHIP OF THE DOCTOR TO HIS WORKSHOP

C. HARVEY AGNEW, M.D., Toronto. The influence of the hospital on the practice of medicine while evolutionary has been actually revolutionary. A few decades ago the average doctor was very little interested in the hospital. The majority of patients were treated at home. Only as a last resort would a patient consent to go to a hospital of which there were very few outside of large cities and those were comparatively closed to a small staff.

Now the picture is changed. There is a vast chain of hospitals everywhere. More and more medical work is being transferred to the hospital so that the doctor must ally himself more closely with his workshop today than he did in the past. The medical profession is realizing its responsibility and obligations to the hospital and staff appointments are now properly appreciated. An increased interest is being manifested in staff meetings with more co-operation and *esprit de corps*. Particularly gratifying is the greater co-operation between medical staff and the administration groups in hospital work.

What of the future? Hospitalization cannot but increase thereby making it more essential than ever before that every doctor have access to some hospital. The effort to lessen the cost of diagnosis will probably result in greater utilization of hospital facilities by doctors whose co-operative practices may be grouped about the hospital itself. Should health insurance ever come the experience of other countries would indicate that the relationship of a large portion of the profession may undergo considerable change.

The increasing utilization of public ward services by industrial and social organizations for the hospitalization of patients on a benefit or co-operative scheme, many of whom could afford to pay for a physician is victimizing the profession to an intolerable degree. In a Report of the joint committee

of the British Medical Association and the British Hospitals Association in Great Britain there is shown a definite preference for the payment of the visiting staffs.

It is becoming increasingly apparent that the physician's activities and interests, his future, his very life are indissolubly bound up with the hospital. No more can he hold aloof from the hospital, scorn the multitudinous staff responsibilities, or maintain his professional prestige without that very stimulating and chastening contact with his colleagues in ward and theater.

And with the realization of this partnership has arisen a new sense of responsibility of obligation toward the hospital. The more this duty is realized, the more is a staff appointment appreciated—not as a divine right but as a privilege, as an opportunity for professional improvement for scientific stimulation and for greater service to the sick poor.

Discussion

WILLIAM D. CUTLER, M.D. Chicago. A recent analysis shows that in the United States more than 50 per cent of the practicing physicians have hospital connections. The doctors themselves have been most active in increasing the number of institutions and in devoting a larger proportion of their own time to practice within hospitals. Obviously by so doing the physician saves a great deal of time and energy otherwise consumed in visiting his patients in their homes. In hospital practice the doctor saves money for it relieves him of the necessity of providing in his office such expensive equipment as operating rooms, laboratories, and X-ray machines for diagnosis and treatment.

In the hospital the physician has at his command trained assistants, internes, nurses, and technicians who will carry out his orders, supervise treatment, and in diagnosis, and, in general, greatly increase his effectiveness in caring for the patient.

Another substantial advantage which comes to the physician practicing in the hospital is derived from the opportunities for contact with his professional colleagues. Casual meetings and formal consultations enable him to keep better informed as to what others are doing in his own and related fields.

The present regimen has proved itself of greatest advantage to the patients who save time otherwise consumed in going back and forth to the doctors' offices. Moreover it is an indisputable fact that better care can be obtained in the hospital than in the home.

Slowly but surely the doctors are transferring their care of ambulatory patients to offices which now are provided in many institutions, resulting in the numerous advantages already cited. Even the hospital finds it advantageous for the physician to carry on his private practice within its walls for it makes him more readily available at all hours of the day.

In connection with problems of health insurance, some hospitals have already undertaken to supply

their communities with medical service at a fixed rate. Inasmuch as these arrangements sometimes include medical as well as hospital care, it is clear that our profession is vitally concerned to see that such arrangements are based upon due regard for the physicians' rights—otherwise, the hospital, or insurance company may assume the right to sell the doctor's services without giving him a voice in determining the conditions under which he will render those services.

Surgeons more than any other group of physicians, are dependent upon hospital facilities and, at the same time, they furnish a larger quota of patients. Therefore, it is to them that we may justly look for leadership in adjusting the relationship of our profession to the community through the hospital, in such manner as to safeguard the vital interests which we have at stake.

MEDICAL AND HOSPITAL ECONOMICS

FREDERIC A. BEALEY, M.D. Waukegan, Illinois. The Hon. Newton D. Baker has said recently that "America will be on trial this winter" and we might paraphrase this to state that the American hospital system will be on trial this winter. The solution and the answer to all the problems involved in the situation cannot be prophesied accurately.

The mounting and ever increasing cost of the maintenance of hospitals has been a problem that has confronted all hospital managements during the past decade and has required the continued and correlated efforts of the best financial minds to cope with these changing conditions which are rapidly becoming more acute. Hospitals have been compelled to increase their budgets because of the cost of elaborately equipped X-ray departments and complete scientific laboratories, with their accompanying staffs of high salaried technicians. The supplanting of the 3 year course for nurses instead of 2 years of training, and the demands of physicians and surgeons for more scientific care for their patients in hospitals have meant an increasing financial burden.

It is an evident fact that the average patient cannot afford to pay for the high quality of service which he needs and to which he is rightfully entitled. Some arrangement must be evolved whereby this enormous financial burden can be distributed and paid collectively. Perhaps the costs of hospitalization of many patients could be assumed by some collective agency such as insurance.

It is not exactly accurate to say that communities are overhospitalized. True, there are many unoccupied beds throughout the country. But it is just as true that there are as many and more patients requiring hospitalization who have not the financial resources to avail themselves of these unoccupied beds.

If the Veterans Administration hospitals would restrict their services to diseases and injuries contracted in the line of duty and to dependents of those who made the supreme sacrifice, then many of the

now unoccupied beds in other hospitals would be come occupied.

HOW THE HOSPITAL MANAGEMENT AND MEDICAL STAFF CAN CO-OPERATE IN REDUCING THE MORTALITY OF APPENDICITIS

JOHN O BOWER M D Philadelphia Approx- imately 20 000 die annually in the United States from appendicitis and the complications associated with it. The death rate of 183 American cities with an aggregate population of 43 000 000 in 1931 was 17.9 per 100 000. The increase in mortality from 1910 to 1931 in 60 cities in the United States with an aggregate population of more than 28 000 000 was 31.5 per cent. The death rate per 100 000 in these was 17.4. In 64 foreign cities of corresponding importance with an aggregate population of more than 56 000 000 in 1931 the death rate was 8.0 per 100 000. Why is the death rate in the United States 124 per cent greater than in Europe? Our medical and surgical abilities are certainly equal and our hospital facilities just as good.

Pre-hospital factors are responsible. This accounts for the futility of the efforts of physicians and surgeons to reduce the mortality. The responsibility for the outcome of the patient who enters the hospital with acute appendicitis is the surgeon's. Yet in 90 per cent of the deaths the advice of family friends, druggist and family physician has contributed more to the fatal outcome than the surgeon's management.

Any plan to combat the increasing mortality of acute appendicitis must include a program of publicity. The problem of the increase is not the surgeon's primarily; it must be met by the co-ordinated efforts of a national organization such as the American College of Surgeons, the departments of health of every city, and by the medical staff and management of all hospitals. The success of the plan for the reduction of mortality of acute appendicitis as it pertains to the individual hospital depends upon co-operation between staff and management.

The member of the staff chosen by the chief of staff and the medical director or superintendent should preferably be a surgeon, but if he is vitally interested in the campaign, experienced in clinical research and willing to supervise the details incident to statistical studies, he should be chosen without regard to rank or preference.

For a successful plan of publicity there must be (1) an analysis of all clinical records of acute appendicitis both private and ward of the previous 2 years; (2) presentation of results of analysis to the medical staff and those physicians sending patients to the hospital; (3) a letter with explanatory detail enclosed (in the form of a sticker warning) mailed to above mentioned physicians; (4) surveys made and letters noting any progress together with stickers sent out at varying intervals of from 3 to 6 months; (5) a complete survey made at end of current year with results.

As soon as the survey is completed the results must be presented to the staff, outside physicians and the public. Sticker warnings sent to the family physician who in turn sends them to his clientele will be particularly effective. However one of the greatest aids is the frank discussion of the hospital mortality; it must be talked about; it must be visualized; it must be brought into the open.

OXYGEN THERAPY IN HOSPITALS, EQUIPMENT AND MANAGEMENT OF SERVICE

WILLIAM THALIMIER M D Chicago Anoxemia is the one fundamental indication for treatment with oxygen. The only accurate method for determining the degree of anoxemia is actually to determine the amount of oxygen present in the arterial blood. The use of oxygen therapy in our hospital has increased until now we are trying to anticipate the development of anoxemia and prevent it, or if we cannot do this, at least to use oxygen at the earliest indication of anoxemia.

The advantages of the oxygen room are accurate and constant control of percentage of oxygen, conditioning of the temperature, and humidity of the atmosphere, ability to give the patient complete nursing and medical care as in any other room, relieving the patient of the sense of confinement as in an oxygen tent. The disadvantages of the oxygen room are mainly that it is more expensive to erect, uses more oxygen, and requires a special nursing force.

The advantages of oxygen tents are mobility, that is, one can bring the tent to the patient's bed, they are less expensive than oxygen rooms, and require less oxygen. The disadvantages are that some patients are badly affected by the feeling of confinement in the tent, very restless patients are difficult to control, and delirious patients impossible to control. It is difficult to maintain a 50 per cent oxygen content because of having to open the tent to feed and care for the patient; it is more difficult to give nursing care; more difficult to control the temperature. Oxygen tents require constant supervision by someone with the proper technical training.

The nasal catheter method has the advantages of simplicity and economy. The main disadvantages might arise from discomfort caused to the patient, limitations when the patient is restless or delirious and the necessity of care on insertion of the catheter by a physician and constant supervision by him. There is the danger that if the catheter is inserted too far into the pharynx, that the patient may be forced to swallow the oxygen mixed with air, or the stomach may even become distended with this atmosphere.

It is imperative that one member of the clinical staff be interested in oxygen therapy from both the therapeutic and research points of view. He can train a technician, nurse, or interne in all of the essentials, he can stimulate the rest of the staff to maintain an open mind as to the value and usefulness

of oxygen therapy. He will find many fields still open for research and many opportunities for careful scientific observations.

For the proper care and installation of oxygen tents, for the use of an oxygen room, to be certain that 50 per cent oxygen is being maintained, and that equipment is not being neglected or damaged it is absolutely necessary to have the services of an able technician.

It is my hope that it will be possible to reduce the cost of oxygen therapy service in hospitals and in homes so that oxygen treatment can be given a larger trial earlier in the course of various diseases, and so that many more observations can be made to determine the extent of usefulness in what I consider a very valuable therapeutic aid.

DISCUSSION

LEONARD W. CRILE, M.D. Cleveland, Ohio. It is the custom at the Cleveland Clinic to deal with depression and shock prophylactically. Since the basis of energy is oxidation it is through oxidation that the electrical potential of the cells is built up and maintained, and therefore it is through oxidation that the normal activity of all the organs and tissues of the body is maintained. In depression and shock there is a failure of the actual oxidation in the body that is to say a failure of the internal respiration of the body corresponding to the degree of the depression and shock. If in the course of a surgical operation the patient is depressed by surgical shock or by hemorrhage or by infection, or by crises of hyperthyroidism, it means that countless millions of organic molecules have broken down and these can be restored and repaired only by rest, sleep and normal oxidation.

We treat our patients on a statistical basis that is, our indications for preventive treatment are based upon the statistical evidence, not the clinical evidence in each group of patients. If we are proposing to perform an operation upon the common duct in a jaundiced and sick patient, if we are resecting the large intestine for carcinoma if there is an emaciated patient with hyperthyroidism or a case of hyperthyroidism in which emaciation, myocardial decompensation, nephritis, etc. are present, if a resection of the stomach is to be done if for any reason the risk is poor then regardless of the cause, in all these cases we give a blood transfusion in advance of operation, intravenous injections of glucose, injections of normal saline and urge water by mouth or give it by hypodermoclysis—thus the electrolytic balance is built up before the operation, and then during the operation we maintain the body temperature in certain of these cases by diathermy.

We use local, regional, or spinal anesthesia together with a small amount of nitrous oxide oxygen we avoid deep, general anesthesia which interferes with the internal respiration, that is, the oxidation, which means that the anesthesia itself is doing the same thing to the patient as the surgical operation. When we have finished an operation per-

formed under the above listed conditions, the patient's condition may seem to have been very little disturbed by the operation but we know from statistical experience that that patient is still in the bad risk class. We, therefore, put the patient immediately into an oxygen tent and give him infusions of saline solution and we protect him against pain. We continue the protection of his body temperature by applying diathermy if there is any fall below the normal.

One of the most important measures of all is the immediate use of oxygen that is, putting the patient into an oxygen tent. By doing this we have to an extraordinary degree cut down the mortality rates in these various bad risk patients. For instance, we now have a series of 1,473 operations for hyperthyroidism in patients under 45 years of age without a death. We have seen the mortality rate fall in the whole group of bad risk operations.

Not only does this general plan of maintaining a high level of resistance in the patient prevent the breakdown of the myocardium, of the kidney, the liver, the pancreas, and the brain, but it sets up the best type of defense against infection, pneumonia and wound infection. In other words, we have set up a formula for raising and maintaining the vitality of the patient before, during, and after the operation and one of the essential factors in this formula is the oxygen tent.

PERTINENT PROBLEMS AFFECTING HOSPITALS AND THEIR SOLUTION—FROM A NATION WIDE SURVEY

E. MURIEL ANSCOMBE, R.N. St. Louis. Several factors are contributing to the lowered occupancy of our hospitals. Non-tax supported hospitals are doing more than their share of free work, but are being deprived of the patronage of patients who can afford to pay, by the admittance of private patients to city hospitals. Some plan should be evolved whereby private patients are entirely excluded from public institutions, and non tax-supported hospitals given financial aid for each charity patient treated.

Group insurance may be a partial solution of the hospital's financial problem. It should, however, provide protection for the individual and prove satisfactory to the physicians.

Articles and editorials which have appeared recently in different professional magazines indicate the need of a specific preparation for the hospital administrative field. Should not some provision be made for an educational program and registration of hospital superintendents that will make it incumbent upon hospitals to employ a properly prepared superintendent if they wish to obtain institutional membership in the American Hospital Association and become approved by the American College of Surgeons?

Boards of Trustees would be taking a step in the right direction by appointing to their staffs only those physicians who have no other hospital

affiliations. This would stimulate a sense of ownership and personal responsibility in institutions. With their patients concentrated in one hospital physicians could devote more time to planning and carrying out an intensive teaching program. They could give closer supervision to the patient's history and have more time for research work.

Without careful supervision and follow up work internes will not get the best which the hospital has to offer. Hospital administrators should feel their responsibility in the development of the interne. The largest hospital does not always furnish the best training; it depends largely upon the organization, the research spirit which prevails and the interest of the staff members in the interne group.

Hospitals are being criticized today for turning out too many nurses. The adoption of uniform standards by a national board or commission working in conjunction with the National League of Nursing Education would automatically eliminate many schools and just as definitely result in a marked decrease in the number of students who are admitted to our schools.

Discussion

W. HAMILTON CRAWFORD, Hattiesburg, Missis. suppl. For several years it has been my conviction that field secretaries should be established at geographical points by the American Hospital Association so that a more intimate relationship might be developed between the members and the association.

The pivot man in any hospital is of course the superintendent. How may we be expected to convince a public that certain recognition should be extended hospitals when staring so many communities in the face is an exhibit of incompetency bearing the title of superintendent?

Several superintendents today are uncertain of the permanence of their positions because of competition of members of their boards seeking to supersede them. We may expect this situation to continue until an intelligent standard is set up for extending recognition to those qualified.

Why not create the American College of Hospital Superintendents to stand out as a separate and distinct ethical and influential college presenting fellowships only where requirements have been fully met?

A plan of public relations as outlined by the Committee of the American Hospital Association would undoubtedly create the proper perspective between hospitals and society.

A three fold program to solve pertinent problems affecting hospitals should include it seems to me the following:

1. Program of public relations.
2. American Hospital Association program as advocated by Plan and Scope Committee.
3. Establishment of the American College of Hospital Superintendents.

ECONOMIC CONDITIONS AS THEY AFFECT CANADIAN HOSPITALS AND HOW THEY ARE BEING MET

ARTHUR J. SWANSON, Toronto. The hospitals of both Canada and the United States are having a difficult time and are frantically searching for new means of increasing revenue. We in Canada have endeavored to gain some measure of relief through five major means.

1. *By reducing expenditures.* In addition to the reduced prices of commodities many savings can be made through using more up-to-date equipment, through rearranging the duties of the staff so as to allow more evenly distributed employment and through the rearrangement of hospital clinics so that space is kept busier.

2. *By selling hospital service to the community.* By setting out deliberately to give the utmost in service to the public and your staff doctors a considerable amount of business can be salvaged at this time. To my mind it is good service that is going to be the deciding factor as to whether the hospitals will be kept busy.

3. *By making the state assume its responsibility to indigent and part pay patients.* In Ontario the Government sets the rate which may be charged public ward patients at \$1.75 per day and 90 cents for infants born in the hospital; this amount to be paid by the patient or if that is impossible by the municipality sending in the patient. In addition to this \$1.75 per day the Government of the Province pays 60 cents per day for every patient in the public wards and 30 cents per day for every infant born in the institution. It is admitted that this rate does not by any means cover the cost of maintaining the patients even in the lowest priced accommodations but the hospital receives a definite amount for patients who otherwise would be treated free. In other provinces the rate varies. When it became evident in Ontario that the government intended to reduce the grant a large deputation of the provincial hospital association met the Prime Minister and some of the Cabinet members and succeeded in maintaining the grant rate. This indicates what a well organized hospital association can do to keep the needs of the hospitals before the Government and the public at all times.

4. *By relief from taxation and other duties.* Thousands of dollars are saved annually for Canadian hospitals because most articles of hospital equipment are exempt from duty. Moreover the hospitals are exempt from the payment of sales tax on everything purchased for hospital use even including material used for additions to existing buildings. The exemptions were made through the efforts of our various hospital associations and our very energetic director of Hospital Service for the Canadian Medical Association.

5. *By a contributory system.* This system may be called "hospital insurance" or "advanced payment system." Call it what you will this is something which must be seriously considered by all hospital

administrators before long. Some of our hospitals have found this system a very satisfactory way of insuring revenue. Prepayment certificates are being issued whereby potential patients buy in advance certificates entitling them to a definite value in hospital service. By means of these certificates payment for hospitalization is spread over a considerable period before, during, and after the actual period of hospitalization.

OBLIGATIONS OF GENERAL HOSPITALS IN PROVIDING BETTER SERVICE FOR THE CANCER PATIENT

BURTON J. LEE, M.D., New York. The American College of Surgeons in co-operation with the American Society for the Control of Cancer has been engaged for some years in the organization of cancer clinics in this country and in Canada. Although splendid cancer institutes exist in some of the larger centers, the bulk of the vast numbers of patients suffering with cancer inevitably find their way to large general hospitals where adequate service should be provided. These institutions must realize the obligation which rests upon them in connection with this major health problem.

To meet this need cancer clinics with satisfactory surgical and radiological equipment and well trained staffs are being organized all over America. Indeed, no large general hospital can be considered a complete institution today unless a well organized cancer service exists within its doors. It must be borne in mind, furthermore, that cancer itself is a distinct field apart from general medicine and surgery.

A cancer clinic to be complete must incorporate the new science of radiology with the co-operation of an intelligent and interested radiologist who has at his hand modern radiological equipment for diagnosis and treatment. An adequate supply of radium is necessary but more important is a group of men trained to use this agent intelligently. The technique of radium therapy is a science and an art in itself but it cannot be separated from proper surgical technique inasmuch as many special surgical procedures must be carried out in connection with radium therapy. A pathologist interested in neoplastic diseases is one of the key men in the personnel of a cancer clinic. But the care of a cancer patient can never be assigned to a single individual. Group judgment is necessary if the patient is to receive the best in diagnosis and treatment.

DISCUSSION

HOWMAN C. CROWELL, M.D., Chicago. The success of the hospital today can be measured only by the condition of its patients after they have left its doors. Yet the future of the discharged patient is in most instances entirely unknown to hospitals. He might well be called the forgotten patient.

Follow-ups are important not only to gauge the efficiency of the hospital's staff, but to make sure that the treatment given the patient will be of more than temporary duration.

Hospitals must induce their patients to return for re-examinations. If they desire to make their services of real and lasting benefit, they must install new record systems with a workable plan for definite follow-ups.

FOLLOW-UP AND STUDY OF END-RESULTS AS CARRIED ON BY THE MAYO CLINIC

ALFRED W. ANDERSON, M.D., Rochester. The taking of careful histories and the recording of physical and laboratory reports are essential to the diagnosis of a patient. But the treatment of future patients with similar ailments depends upon the results accomplished by the medical or surgical treatment instituted. It is true that one may be capable of remembering the results obtained in some particular case or in a small group of cases, but in order to make a thorough analysis of a large series of cases, much depends upon the follow-up study.

In some departments of the Clinic, follow-up data are obtained by personal letters to family physicians or to the patients themselves. In other departments circular letters pertaining to the specific disease are mailed at regular intervals or at times when special investigation is being made. These data are often supplemented by photographs, roentgenograms, laboratory, ophthalmological, neurological, and physical examinations while others who have failed to get the desired results are encouraged to return for re-examination, which affords evidence for the more accurate follow-up study. Letters from patients are not always reliable, as the results may be colored by the amount of the outstanding account or the disability insurance they are receiving. The report of the family physician is the most valuable follow-up system.

Once all these data are acquired, it is essential to record them either on the history on charts, or on cards for mechanical tabulation which permits comparison of pretherapeutic findings in order to evaluate results accomplished. Therefore, it is obvious in comparing the results obtained by the various therapeutic measures that one readily learns which treatment is valuable, and by expounding our faults further thought is stimulated to arrive at the correct diagnosis and the best treatment to employ.

FIXING THE TRIPLE VIEWPOINTS ON NURSING—DOCTORS, NURSES AND HOSPITAL EXECUTIVES—

MARY M. ROBERTS, R.N., New York. Our system of nursing education has been surprisingly good, but it is now outworn. We need a new system to free the hospitals, which are service organizations, of the economic responsibility for educational institutions. The most vital part of a nurse's training must always be secured where the patients are—in the hospital—but by wise use of existing educational institutions for science courses and other academic work, the change can be brought about. A good deal depends upon the hospitals' willingness to so organize their nursing services that there shall be

at least a skeleton organization of graduate service a service apart from the numbers of graduates needed for supervision. Into well organized services we shall be able to project students for training in the expectation that they will constantly see and therefore practice good nursing—an outcome deeply desired for patients by doctors and nurses alike.

Today we have many more nurses than we need to meet effective demands, and much of the over production is of poorly prepared nurses. In a study of the nursing services of sixteen middle western hospitals, the American Nurses Association recently discovered that only 33 per cent of the applicants were eligible for staff nursing.

Doctors know extraordinarily little about nursing. With their willingness to help, and with the co-operation of nurses and hospital executives together with the aid of the public, nurses can be better prepared. It is upon the public that the responsibility for the education of public servants should rest.

Hospital nursing service and school of nursing should never be thought of as synonymous terms even when the school contributes richly to the service and the service to the school. The hospital is responsible for its own nursing service. It should be freed from the economic and educational burden of a school.

School of nursing must be made to mean a place in which young women are prepared for service as *graduate nurses* in what may be called first level positions. This implies a sufficient body of basic sciences to provide a background for a rounded clinical preparation including mental and communicable disease nursing and the principles of public health. Further preparation than that should be secured through postgraduate courses.

Discussion

DONALD GUTHRIE, M.D., Sayre, Pennsylvania. I do not believe that the medical profession criticizes nursing for a lack of training or practice. Most of the criticism is brought forth because of the nurse's inability to adapt herself to her patient and to her own surroundings.

Psychology has been wisely added to the curriculum but as a science it is difficult for the average pupil to understand. Would it not be better to teach psychology in a more practical way and to bend our efforts toward developing the personalities of our students? I am satisfied that if our nurses could be skillfully trained in practical psychology there would be much less criticism of their work by the public and by the medical profession. The art in nursing and in medicine must never be replaced by pure science, for if it is, it will be unfortunate for both professions.

BASIC STANDARDS FOR SCHOOLS OF NURSING

REV ALPHONSE M. SCHWITALLA, S.J. Ph.D. St. Louis. In advocating any set of basic standards for schools of nursing, the first principle to be rec-

ognized by the school is the *educational level from which its students are derived*. Essentially the school of nursing is a professional college. That does not mean that schools of nursing should blindly and uncritically take over the whole sum and substance of college administration, but the school's attitude toward a student should be that of the solid college of arts and sciences.

The school of nursing must understand the *life for which it is preparing the student nurse*. Because of the constantly increasing stress and complexity of our world the school must differentiate between cultural courses, basic sciences, medical courses, and nursing courses in the curriculum. If the school of nursing is of collegiate rank, then surely it must impart fundamental collegiate instruction in the principles of the use of English in public speaking, in the fundamental viewpoints of economics—in addition to theoretical preparation in medical and nursing courses.

It is incumbent upon the school of nursing to develop to instill into its students and to foster in them the ideals of the nursing profession. From her studies there should develop in the mind of the thoughtful student at least the beginnings of a formulation of the nurse's place in the nation's life. And from that understanding there will be derived a broader outlook on life, a deeper insight into the problems of mankind, a firmer grasp upon the fundamentals of living which enable the individual nurse to rise above those smaller annoyances concerning her employment, her hours of work and the nature of her work, which have in the past stood in the way of success of many creative endeavors in the field of nursing education.

Discussion

J. DEWEY LUTES, Chicago. One requirement for entrance into a school of nursing that seems to be generally accepted is that of a high school diploma—and rightly so. However, this must not be considered proof of a girl's ability to become a nurse. It is merely proof of her intellectual capacity to reach a certain level by way of a prescribed route.

We must make provision in our schools of nursing against the graduating of those who fail to acquire the proper attitude of mind. It is not enough to pour out instruction of which a sufficient amount can be retained in the memory to pass a written examination. We who administer in the schools of nursing must analyze students in such a manner that the failures are eliminated.

We must not permit education to stop at the end of the school career. We must encourage and put into operation some plan whereby the individual will continue to learn and improve herself and her profession as the years pass.

The members of the faculty must be selected on the basis of their ability and fitness in this special field. And graduate nurses must be selected for departmental positions in the same careful manner in which a student is admitted to the school.

DEPRESSION DEVELOPMENTS IN RELATION TO HOSPITAL ECONOMICS

B C MacLEAN M.D. New Orleans. More attention has had to be given during the depression period to the economies of hospital operation as a result, many new experiments have been tried. It was inevitable that some startling schemes would be advanced in a frantic attempt to bolster revenue. Hospitals have been advised to open beauty parlors, barber shops and soda fountains. It is wise to remember that a hospital should not stray too far from its functional field even in times of depression. On the other hand, there are some profitable activities such as the operation of a doctors' exchange or a nurses' registry and the provision of office space for doctors which can reasonably be considered within the province of a hospital and which can be successfully instituted if local conditions permit.

Interesting to all hospitals is the success which has attended the inauguration of cafeteria systems for the feeding of employees, nurses, and internes. Another development has been the establishing of central supply rooms for surgical supplies and also central nourishment kitchens for the preparation and dispensing of the between meal extras.

Nursing education is more theoretical today than it was in the past. But the main purpose in any system of nursing education is always the same and cannot be too greatly emphasized—the *comfort and care of the patient*. It might help if our nursing faculties contained more bedside preceptors and less classroom Ph.D.s.

Hospital insurance although not a panacea for all our ills, seems to offer at this time the greatest promise of deliverance from economic pain. The medical profession should realize that hospital insurance plans, as at present conceived, offer a bulwark of defense against other radical trends which might revolutionize the practice of medicine.

The Federal Government itself has entered into direct competition with private hospitals in the care of veterans whose disabilities have been incurred outside any line of public duty either civil or military. It is to be hoped that the splendid efforts of the medical and hospital associations to stem this tide may be successful.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE X RAY DEPARTMENT

EDWARD H. SKINNER M.D. Kansas City. In many localities there are several hospitals, none of which offers sufficient within its own walls to attract or pay for the full-time consultative service of a radiologist. With technical demands satisfied by a full time technician, one radiologist can easily serve at least four hospitals each day. Modern roads and rapid transportation make 50 mile trips as easy as any twenty five blocks in street car days.

There is no reason why the technicians in small hospitals should not serve both the radiological and pathological laboratories. Bookkeepers, record

clerks and operating room nurses may easily become radiological technicians without sacrifice to either service.

The compact arrangement of all laboratories and operating rooms would aid in the co-operation of technical assistants avoid many steps by many people concentrate and increase the demands for laboratory examinations promote more consultations between attending physicians and laboratory consultants eliminate the gossip infested doctors lounge rooms.

The sterile cystoscopic room can be adjacent to the X ray department and be served by the single X ray transformer for pycnograms. The plaster room can be next door and be served with fluoroscopic fracture service. The combined plate viewing and radiologist's office should contact the pathologist's sanctum to afford that co-operative consultative service so beneficial to attending surgeon, physician, and patient.

Economies in radiological fees can be effected by securing the co-operation of the staff in asking for radiological consultation for the particular diagnostic problem rather than making a blanket demand for extensive and costly technical procedures.

The co-operative fluoroscopic consultation of clinician and radiologist can be a great saving and afford increased values to the patient and greater glory to the hospital's reputation. Stereoscopy is beautiful but rarely necessary.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE PHYSICAL THERAPY DEPARTMENT

JOHN S. COULTER, M.D. Chicago. It is possible for every hospital whether large or small to have a physical therapy department without the expenditure of a great sum of money if certain principles are observed. First of all, to be efficient a hospital physical therapy department must be under the control of a physician. In a large city this can be accomplished without any difficulty. In the smaller town where there is no physician devoting his time to physical therapy this department should be under the direction of the X-ray department.

The second requirement is well trained personnel. At the present time there is no course which definitely provides X ray technicians practical training in physical therapy. It is hoped that the societies of X ray technicians and physical therapy technicians can work out a satisfactory course of not more than 12 months to fulfill this need, inasmuch as many calls for technicians request an individual capable of taking charge of the technical work in both the X ray and physical therapy departments.

A hospital physical therapy department can be started without any apparatus except that made by the hospital carpenter, mechanic, and electrician. Proper equipment is essential for much of the needed treatment but no hospital should hesitate to start a department without equipment so long as available space is provided, and a physician is placed in charge assisted by well trained personnel.

In order to put before the hospital staff information relative to physical therapy one staff meeting a year should be devoted to the demonstration of the work of this department. Demonstrations should be scheduled for clinics lectures given to internes and nurses.

Records are the most important aids in the scientific success of a hospital physical therapy department. To be of value they must conform to the general record system of the hospital and form part of it.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE ADMINISTRATION OF ANESTHESIA

JOSEPH MCNEARNEY M.D. St. Louis. In the present day the anesthetic department of a hospital should be staffed by physician anesthesiologists who have had special training in the field of anesthesia. There is a greater field for medical anesthesiologists now than ever before. The young medical graduate who will take special training in this field will be the anesthesiologist of the future. Medical schools are beginning to realize that a good knowledge of anesthesia is essential.

The nurse anesthesiologist is an economy to the hospital but not to the patient. The patient pays the same fee to the hospital for the anesthetic given by the nurse anesthesiologist as he would pay a physician anesthesiologist. In my opinion anesthetics should be on a flat rate fee basis, in keeping with the economic condition of the clientele of the hospital. The surgeon is then in a position to inform the patient what he will be charged for the anesthetic in estimating his probable hospital cost.

The hospital feels that it furnishes the equipment and materials and should be compensated for their use—which it should. Nevertheless the anesthesiologist is entitled to remuneration *in proportion to the amount of work done* whether he is working for the hospital on a salary or on a percentage basis.

A rather large savings can be made in the anesthetic department in the use of gases for anesthesia by having the proper preliminary medication and using soda lime filters.

EFFICIENCY AND ECONOMICS AS APPLIED TO THE ADMINISTRATION OF FOOD SERVICE

EUGENIA SHRADER St. Louis. With the present low price level of food commodities it is possible for certain savings to be made in the dietary departments of hospitals. The problem of the dietitian is how great a saving can she bring about without relinquishing her present standard of efficiency.

First of all, it is paramount that there be a well trained dietary staff to direct and help carry on the work of the department. With such a staff we know that only adequate diets would be considered in planning economical menus.

Since a centralized purchasing department is the general rule in most institutions it behooves the dietitian to be in close contact with this department.

To effect savings and add variety to her menu the dietitian must be responsive to any quick buys which the purchasing department feels advisable. On the other hand the purchasing department must be just as flexible and responsive to the needs of the dietary department.

The preparation and service of foods are exceedingly important. The dietary staff should ever be on the alert for variety in the preparation of food stuffs. Therefore, the kitchen should also be an experimental station where new recipes are tested on a small scale before being incorporated in the menu. This can be made a valuable part of the practical training of student dietitians.

The insulated cart seems to be the most efficient and economical means of serving food to the ward and also to the private patient. Astonishing savings can be effected by installing cafeteria service for hospital personnel.

The student nurse plays an important rôle in this economic readjustment. In the dietetic laboratory she should be taught the importance of a well balanced diet, how this diet may be adjusted to meet the demands of certain diseases. She should also be taught the value of food and food service from an economic as well as a therapeutic standpoint. The attitude toward food that the student nurse gains through her laboratory training and experience will be one of the deciding factors as to her degree of usefulness in the ward food service.

EFFICIENCY AND ECONOMICS IN HANDLING SURGICAL DRESSINGS AND SUPPLIES

SISTER PHILOMENA R.N. St. Louis. The hospital executive faces the problem of giving prompt efficient, adequate hospitalization to the sick of the community with less money than has ever before been at his or her disposal. Economy in the handling of surgical dressings and supplies can be made a great aid toward this end.

Adequate supervision of the preparation of supplies, their distribution and the procedures necessary for their repeated use and maintenance can be made to yield large economies.

Central distribution stations seem particularly economical. Such details as the size of the gauze packs, the carefully studied distribution of the packs to the various surgical units and attention to the special desires of the attending surgeons yield valuable results. If different grades of gauze are purchased for different purposes, economies are also bound to result. The preparation of Iodoform gauze drains cut into proper lengths minimizes waste, and through a practical method hospitals can easily effect the proper sterilization of such drains.

Savings can be effected in the preparation of physiological saline solutions if the needs of the various departments of the hospital are kept in mind in planning strength and size of containers. The proper handling of surgical needles and sutures reduces costs to rather an appreciable degree.

The use of packs, for example, for laparotomy operations, blood transfusions, etc. containing all the equipment usually found to be necessary for each particular operation, has also been found to result in diminution in costs.

Economical administration promotes co-operation within a department and thereby insures increased efficiency.

GREETINGS FROM TRUSTEES OF THE HOSPITAL OF ST. LOUIS

SIDNEY ROTHSCHILD, St. Louis Overexpansion and a disregard for the law of supply and demand prevalent in every phase of our national life affect hospitals in the same way as they do any other business organization or industrial concern. Market fluctuations that have affected business investments and wiped out fortunes have also resulted in a depreciation of hospital investments and greatly reduced the income from hospital endowment funds. Hospital trustees are keenly aware of the financial stress and of community needs at this time. Hospital administrators are business men and women. If they did not possess more than an average amount of business ability they would not be selected for their positions.

Trustees have a right to expect the most loyal co-operation from superintendents in their efforts to interpret community needs and safeguard community funds. They in turn, are under just as strong an obligation to be loyal and staunch supporters of the superintendents. We must realize that hospital superintendents have been working under a great handicap to maintain the same standards and service with a greatly depleted income.

Trustees, to whom the administrator is responsible for the execution of hospital policies, are likewise responsible to the community for the judicious expenditure of funds entrusted to their care. It is no small responsibility for regardless of whether the institution is tax-supported or non-tax-supported, the money comes from the community.

Lowered bed occupancy, hospital deficits, and other problems have created many perplexing situations and anxious moments for hospital trustees and administrators. The hospital as an educational health center is rendering a service that cannot be duplicated by any other institution. But is there any other institution that would be expected to serve the community month after month, year after year at a financial loss?

The hospital should not be less humanitarian in dealing with the public but more businesslike. We need more definite business policies in hospital management. There should be legislation, moreover to protect the hospital from exploitation.

CRITERIA TO BE OBSERVED IN SELECTING THE GOVERNING BODY OF A HOSPITAL

C. W. MUMFORD, M.D., Valhalla, New York: A governing body of a hospital to be proclaiming, must include variety in its membership as to age, sex,

wealth, social position, and business experience. We need straight thinkers on our boards, trustees who will consider matters not only in the light of business, but in terms of human values.

It is perhaps best not to include a physician on the board. Even though he may be entirely unbiased in his medical affiliations, the remainder of the medical staff usually resents his membership and loses sympathy with the purpose of the board. Wealthy men make valuable members if they are active. The ideal situation is to find a wealthy man who is definitely interested and willing to do his share of work.

Women should be represented on the board. It is well worth while, also, to have a representative of each class in community life. Therefore, a man who knows the needs of the working man and has his confidence should be made a trustee.

It is wise to give honorary membership to the principal officers of two or three prominent religious sects of the community. The hospital which can gain the endorsement of clergymen of all faiths will be more consistently supported by the public.

An ideal board of trustees would include an architect, a banker, a lawyer and a merchant. Care must always be taken, however, to make these trustees from the various walks of life understand that their firms are not to be preferred with the hospital's orders.

The greater his experience in large affairs and management of people, the more readily can the board member be trusted to act wisely in the performance of his duties. Persons of large affairs who have been accustomed to supervise or who have been a part in a working organization are to be desired. The surest way of gaining the interest of the trustee is to give him something definite to do and to keep him supplied with tasks to the extent of his willingness to work.

Care should be exercised so as not to select several persons who are closely related else the public will feel that one family is in control of the hospital. New members need to be educated in the history, the ideals, the traditions, and aims of the organization. We need more young, mentally alive citizens on our boards but they must not be the "go-getter" salesman and promoter type who refuses to act wisely and with reasonable deliberation.

If our board is carefully selected at first, if we maintain its balance as we make new appointments, it can, with the rarest exceptions, be depended upon to function for the good of the hospital and the community.

Discussion

FRANK C. RAND, St. Louis Trustees should so guide the hospital that it will help the patient first. It is difficult but necessary that all of us should realize that each hospital patient is an entity within himself—separate and distinct from every other human being—and, so far as it is practicable and possible, should receive sympathetic individual attention and treatment.

A trustee must serve without salary must be a man of strong constitution of a low nervous organism, one who is not sensitive to sudden shocks and of fine recuperative powers.

It is short sighted to delegate to committees of the board—or for that matter committees of the staff—functions properly belonging to the administrative officer. Concentration of responsibility facilitates action for which credit or blame can be definitely fixed.

Various types of human activity differ mostly in form while in substance there is an underlying analogy that makes them closely akin. To the most casual observer there may be little resemblance between hospital trusteeship and the square circle but 18 years of experience has developed an empirical knowledge that forces on me the inevitable conclusion that they are of the same family.

RESPONSIBILITY OF THE GOVERNING BODY IN SELECTING THE SUPERINTENDENT

CHRISTOPHER G. PARNALL, M.D., Rochester, New York. It is important that members of hospital boards give careful attention to selection of their own membership. Hospitals both public and private are often greatly handicapped by the astonishing ignorance of members of their boards.

Attempts by boards to administer by committee or individual members the affairs of the hospital have proved inefficient and often disastrous. There should be no division of authority. Administrative responsibility should center in a single individual who is employed for the purpose. Except for the executive committee, all committees should be advisory.

The superintendent should be regarded always as the agent of the board. He should be responsible for the employment of all department heads and should be consulted regarding appointments to the medical staff. He must be a leader and should be left free to make decisions for which he is always held responsible. A medical training is a distinct advantage. If a layman he should have access to medical advice, and ability to judge of its soundness. He must be alive to the problems of the medical profession and sympathetic with medical progress.

Until hospital boards generally appreciate the necessity for executives of real caliber and offer inducement in opportunities and compensation which will make hospital administration an attractive career the individual board will face its major problem when it becomes necessary for it to obtain the services of an executive who can be relied upon to direct the destinies of a modern hospital satisfactorily to its board, its medical staff and its community.

HOW HOSPITAL TRUSTEES CAN KEEP ABREAST WITH THE ADVANCES IN HOSPITAL ADMINISTRATION

MATTHEW O. FOLEY, Chicago. The best, most practical, and most satisfactory way for a trustee to keep abreast of the times in hospital administration

is for that trustee to attend board meetings regularly and listen to what the superintendent has to report. Besides giving an account of the current operation of the hospital, the progressive superintendent will try to help board members get an idea of trends and developments in the field and so attendance at a properly organized and well conducted board meeting is a practical education for a trustee.

Reading journals attending conventions and conferences, actively working on committees are most helpful in keeping the trustee abreast with the advances in hospital administration. But if the trustee will attend board meetings he will learn much about progress in the field of hospital administration which will make more valuable his service on the board.

There are far too many hospital boards which utterly fail to appreciate the responsibilities of their superintendents and the relation of the superintendent to the board. There are many hospital board meetings at which the superintendent is not permitted to be present, and there are too many hospitals in which the executive agent of the board is overwhelmed with detailed tasks ranging from fixing a broken down piece of equipment to collecting overdue accounts.

Too many hospital boards employ a superintendent presumably because they believe that this person knows more about hospital administration than any of their number and then they proceed to compel this superintendent to operate the hospital the way they want it operated.

If the superintendent is given a voice at board meetings that is heard with due attention, if he is not hampered with trivial details if he is accorded the co-operation and wholehearted support of the board he will be able to render better service to all concerned and so will improve the administration of the hospital.

REMOVING HOSPITALS FROM THE INFLUENCE OF POLITICS

JOHN A. McNAMARA, Chicago. Municipal county or tax-supported hospitals should be as much above suspicion as are our public schools and their administration should be on as high a level if possible on a higher level, because to hospitals is entrusted the task of returning to society the ill and the injured.

When mismanaged institutions in which graft is rampant in which death rates are high, and in which all ethics and standards of the medical profession are openly disregarded, are removed from the list of hospitals approved by the American College of Surgeons, from the list of hospitals approved by the American Medical Association for intern training, and from all other lists, then and not until then will the municipalities clean house and give to the taxpayers institutions wherein the indigent sick and injured may be cared for in an adequate manner.

It is an imposition on our young doctors and in terms to subject them to the influence of poorly equipped, managed, and staffed institutions. They can only learn vicious tricks and take away with them into practice a large number of false ideas and no ideals at all.

We must not neglect the health of the whole community; we must not allow members of society to die because of improper treatment while we sit idly by and politicians fatten on the misfortunes of citizens. It is time that all good hospitals band together and protest that politically dirty and corrupt institutions are removed from the lists of accrediting organizations; they must ask that a full survey be made of these institutions and that they be taken from the lists unless politics are completely divorced from all healing institutions.

DISCUSSION

EDGAR P. HOGAN, M.D., Birmingham, Alabama: It must be recognized that to remove hospitals from the influence of politics is a difficult problem. So many tax-supported institutions are still under political control because those who are responsible for the management of hospitals have not informed the people who are omnipotent in making laws, as to what form of government and administration is best for the hospitals.

It is by legislative enactment that laws must be secured which will stabilize hospitals in government and remove them from the destructive influence of politics. In many states, counties, and cities this has been done. Alabama many years ago by legislative enactment created a non-political board for the control of Bryce Hospital for the insane. The State Board of Health of Alabama and the boards in each county are elected by the state medical society and county medical societies, respectively. They have entire authority and responsibility for the public health work of the state and the expenditure of the public health appropriations.

For county and city hospitals a state law creating hospital boards consisting of five members, one of whom would be elected every 2 years for a period of 10 years, would be a most excellent one. Such a board would remove tax supported hospitals from the influence of politics.

Non-political boards of tax supported hospitals, clinics, and dispensaries can limit the work to charity cases only. Political boards cannot. It is in the interest of the tax supported hospitals, the taxpayers, politicians, private hospitals, the medical and nursing professions, and the general good that politics be eliminated absolutely from the control of hospitals.

HANDLING OF COMMUNICABLE DISEASES IN CONNECTION WITH A GENERAL HOSPITAL

T. R. PONTON, M.D., Augusta, Georgia: To accept and treat in a general hospital patients suffering from communicable diseases is a perfectly safe procedure, and in the smaller city where the num-

ber of such patients is not sufficiently great to warrant the construction and maintenance of a special hospital for communicable diseases, it is the logical method of protecting other members of the community while giving the patients proper care.

Correct diagnosis is the first great essential. It is the unrecognized case that infects others and may even cause an epidemic.

Proper prophylactic measures should be used. Hospital attendants whether they are to attend communicable diseases or not should have all the recognized forms of immunization unless they are known to be immune.

For the care of patients suffering from communicable diseases proper facilities must be afforded. Whenever possible each patient should be placed in a room by himself. Failing the individual room, the next best facility is the cubicle in which a definite space is allocated to each bed and a partial partition placed at each side of this space. When the cubicle cannot be provided patients can be accommodated with safety in the general ward so long as they are grouped properly and the beds spaced sufficiently apart.

Antiseptics should have little place in the management of communicable diseases. For sterilization of some articles used around the patient they are necessary but the basin of biniodide so frequently seen at the bedside is a menace which should be avoided. It gives a sense of security which is absolutely false.

Soap and water are the key to proper technique. For 15 years I have used soap and water with cross-infection so rare as to be negligible. If one factor could be selected as the most important it would be running water. If you use plenty of soap and water and follow the dictates of medical science in measures of prophylaxis, you may be assured that in the general hospital patients known to be suffering from communicable diseases may be cared for with perfect safety to other patients and to attendants.

DISCUSSION

WALTER C. D. KIRCHNER, M.D., St. Louis: While it may be true that communicable diseases may be treated in general wards of hospitals in smaller communities, I believe that in the larger cities it is distinctly desirable to establish and maintain separate isolation wards.

A careful diagnosis relative to infectious diseases is most important. No patient should be admitted to the general wards or open services where there is a suspicion of communicable disease. Cases that are suspicious, such as typhoid, measles, diphtheria, etc., should be very carefully examined so that proper assignment to the ward or division may be made.

In the City Hospital, for instance and especially in the children's ward, all children are isolated in rooms for a certain period until it is ascertained that infectious diseases may be ruled out. It is important that preliminary examinations such as throat cul-

tures blood cultures etc. be made at the earliest possible moment so that the possibility of infection may be determined.

Unless the hospital is provided with proper facilities for handling communicable diseases it is difficult to prevent the spreading of contagion. Chlorinated lime is an important preparation in handling infectious diseases because it has a distinct antiseptic value and can be used readily and easily.

THE INDIVIDUAL DOCTOR'S RESPONSIBILITY FOR CLINICAL RECORDS

WALTER F. COLF, M.D. Greensboro, North Carolina. We as physicians are responsible for clinical records. We are not only responsible, we are obligated first of all to our hospital organization. The standing of a hospital in a community affects the standing of its staff. Its organization depends upon the loyalty of its members.

We are obligated to our colleagues especially to the future physicians now in the making. Careful directions and records of the blunders we have made will act as a beacon light to warn them of impending danger.

The records that we make are future protection to ourselves in legal matters. Again it gives us a better grasp, a broader viewpoint of our case which enables us to formulate a clearer and more concise idea of the pathology involved. When we make a record of a case we are writing the life history of our association with the medical profession.

Our obligation is greatest to our patients. Every patient is entitled to a careful and concise record of our findings so that in case of necessity it may be used to his advantage in the future. The record enables the physician to make a finer diagnosis of his case and thus to better fulfill his duties as consultant and surgeon.

Do you direct your staff to make these histories because they are required by the American College of Surgeons or do you insist upon them because of the value of the record? Has it ever occurred to you to meet with the staff of your hospital bringing with you the criticism of your records by the American College of Surgeons for discussion so that better co-operation may be enlisted? It should be remembered that one of the chief criteria upon which the American College of Surgeons classifies your hospital is based upon the completeness, clearness and accuracy with which you record the work accomplished by your staff.

Discussion

DEWELL GANN, JR., M.D. Little Rock, Arkansas. There is no department in the hospital where the co-operation of the doctor is more essential than in the record room. Here the doctor and the record librarian need the help and co-operation of each other in order to secure records of efficient clinical value. The record librarian of today invites and appreciates constructive criticism of her department. She realizes that without such criticism

from the doctors who are in a position to recognize the scientific value of a record her records will be valueless. No matter what amount of ability the record librarian possesses or how progressive she may be she cannot succeed in producing scientific case records without the intelligent and vigilant co-operation of every doctor.

Just as the officials of any commercial organization are entitled to know the reasons of the profit and loss in the business so also the hospital management has a right to an accurate and honest report of the medical service rendered in its hospital. Medical science will be advanced by the accumulation of such data. Authoritative statistics of one hospital combined with those of other hospitals will furnish material for research. As practically all advancement in medical science has been achieved through research work it is the duty of every doctor to contribute his knowledge to its promotion. Although hospital records have been greatly improved in recent years they are still found to be inadequate as has been highly emphasized in the present research work on cancer. In order to overcome this disadvantage the American College of Surgeons has adopted special cancer sheets which are well worth consideration.

An office-hospital routine which I prepared and am still using at St. Vincent's Infirmary is outlined here in the hope that it may be helpful.

1. During the examination of a patient in the office I dictate in code to a nurse the working diagnosis and what I propose to do.

2. When the nurse takes the patient into an adjoining room so that his clothing may be adjusted, she prepares an admission slip in code which the patient takes to the hospital with instructions to hand it to the record clerk on arrival.

3. After the clerk at the hospital has assigned the patient to a room the slip is handed to a graduate nurse in charge of my patients at the hospital who transfers the working diagnosis on the slip to the progress record together with my recommendations for hospital procedure. I need not see the patient further that day unless I so desire, and the following morning the chart is brought to the operating room with the patient. It is only necessary for me to consult the progress record to know what I am to do for the patient and unless I have been notified of some oversight or irregularity I know the patient is ready for operation.

4. On completion of the operation I dictate to a dictaphone the postoperative diagnosis, findings and procedure.

5. After the morning's work is completed, the hospital stenographer transcribes the dictation to the operative chart and this becomes a part of the record.

6. When the patient is discharged from the hospital my nurse prepares a card, similar to the usual summary card which is sent to my office for ready reference containing all necessary data for essential follow-up, financial and otherwise.

This system takes care of all essential data except the history, physical examination, and laboratory work at the hospital.

THE VALUE AND SCOPE OF MEDICAL SOCIAL WORK IN THE HOSPITAL

GRACE BEALS FERGUSON St. Louis. It is true that medical social work has made its most significant contribution in the study and treatment of medical rather than surgical problems. The reason for this is perhaps obvious, in that medical problems are much more frequently complicated by personal and environmental situations than are those dealt with by the surgeon. The treatment of diabetes or tuberculosis, for example, depends upon the emotional acceptance of the regimen, the economic status, and the participation by the patient to a far greater degree than does the treatment of a fracture.

There are, however, two aspects of surgical treatment to which experience has shown that the social worker can make a valuable contribution first in regard to follow-up and second, in regard to the adjustment of mental and emotional concomitants which we know today can seriously complicate the treatment of patients cared for by a surgeon.

Social studies have shown that efforts on the part of the social worker to secure the return of a patient for a follow up examination after a period of time has elapsed are usually unsuccessful. On the other hand if the social worker interviews the patient when he is first being admitted to the clinic or hospital, lapses and failures to return decrease noticeably.

It is the social worker's responsibility to counteract any adverse objective factors in the patient's environment. She can be of untold assistance to the surgeon in helping the patient adopt a better mental attitude toward his condition, and encouraging him to co-operate with the doctor and the hospital so that his recovery from the operation may be effected in as brief a time as possible.

DISCUSSION

ROBERT E. NEFF Iowa City, Iowa. Time was when the hospital was merely a boarding house for the sick paying no more attention to its discharged patients than hotels today pay to their departing guests. The hospital should be vitally concerned in the discharged patient and assume responsibility to the extent that interest is maintained in the patient until he becomes restored to a normal social environment after leaving the hospital.

The follow up work on discharged patients is the direct responsibility of the social service department and enable the hospital to round out the treatment of patients and restore them to normal environment in other words, finish the job. Without follow-up work on patients, the hospital has no assurance that the job has been completed and may expect to have back on its hands many patients whose hospital treatment has been for naught, chiefly for the reason that proper control during

convalescent care had not been exercised over the social factors necessary for a complete cure.

To handle this problem adequately for the hospital, there must be trained workers who possess specialized training in the basic principles of social work, together with knowledge bearing on etiology, methods of treatment, and prognosis in the various diseases. The proper handling of the patient from the standpoint of social needs must be based largely upon medical factors of which the social worker must have at least a general knowledge and which must be supplemented by the directions and findings of the physician.

Many hospitals have established social service departments on the justification of economic considerations. Financial investigation of prospective patients by social service has rendered very definite financial benefits to the hospital. Also, the matter of the rapid turnover of patients which represents an economic factor of no small importance, is greatly aided by social service.

If we are to treat the patient as well as the disease, we must treat him personally emotionally and socially—this may be accomplished through the means of well trained and experienced social workers.

HOW THE MEDICAL SOCIAL WORKER CAN ASSIST IN THE PRESENT ECONOMIC SITUATION

RUTH LEWIS St. Louis. The time at which the social worker touches most directly the economic affairs of the hospital is on the admission of patients. This is not a routine procedure, and because of its large social components may logically be performed by a social worker. She may determine the patient's eligibility for admission, set the rate he is to pay and as well influence the collection of the account.

At a time when free and part pay beds are at a premium the selective utilization of those available is a grave responsibility of the hospital even though the choice of who shall occupy a particular free bed may not swell the income of the hospital. The medical social worker either through her previous contacts with the patients in the clinic or her relations with other social agencies may be able to contribute information about the patient which will help to make a wise decision regarding his admission.

The pressure on the free and part pay beds may be partially relieved in many hospitals by the efforts of the social worker in reducing the length of stay of patients. In cases where a close working relationship exists between the physician and the social worker and a plan for the after-care of the patient has been made before the patient's admission or early thereafter the average length of stay has been markedly reduced.

When patients are refused admittance to the hospital and feel that they are being unreasonably treated because the hospital is not full and is partially supported by the community. It is the social worker's problem to interpret the hospital's present situation and demonstrate convincingly the practical alternative of home care.

It is in service to patients that the social service department makes its greatest contribution to the hospital. In order to insure complete treatment to its patients the hospital must know the social situations complicating medical care. These the medical social worker supplies. She is also interpreting the hospital's financial limitations and needs. The family, the employer, the minister, the school teacher, the lodge brother, the judge, the family physician are all channels through which the social worker may pass on this information of the hospital's services and needs through her daily contacts on behalf of individual patients.

THE RÔLE OF THE SOCIAL WORKER IN THE DIAGNOSIS AND TREATMENT OF CANCER

ELEANOR COCKERILL, St. Louis. Cancer a disease ranking second as a cause of death in the United States offers a real challenge to the social worker. As the medical profession seeks to perfect the diagnosis and treatment of this disease there is an increasing realization of the vital influence of the social factors which are involved.

The social worker's task is to understand as completely as possible the problem of each individual patient. She arrives at this understanding by acquainting herself with the details of his physical condition—the type and stage of the cancer, the therapy advised, and the possibility of arrest or cure—and by inquiring into his social situation which enables her to evaluate the possible effect of the disease and the obstacles to treatment and observation which may arise. With this information in her possession, she is equipped to bring to the aid of the surgeon any pertinent observations she has made which have a bearing upon his plan. She becomes adviser and interpreter to the patient and his family supplementing earlier explanations by the surgeon, anticipating and meeting difficulties in carrying out the plan of treatment and bringing into action any other social adjustment indicated. Community contacts are strengthened and new resources enlisted.

If the social worker is successful in her rôle, there will be no necessity for the follow-up of delinquent patients. The foundation she lays through interpretation and guidance is permanent and lasting. The surgeon will be able to complete his diagnostic study to carry out a plan of treatment and observe the results through the years which follow. As the social worker carries on her program with the patients assigned to her care, she becomes an effective channel through which information about cancer can be disseminated to the general public. She thus contributes to the diagnostic, treatment research, and educational phases of the cancer program through her rôle as interpreter to surgeon, patient, and community.

Discussion

FRANK L. RECTOR, M.D. Evanston, Illinois
Granted the co-operation of the attending phys-

ician which it is inconceivable not to have, the problem of the social worker is to bring to the physician and the hospital regular reports of the health and welfare of the patient. No fixed rules can be laid down by which this may be done. It is largely dependent upon the common sense of the social worker and her ability to take advantage of all resources that will be of assistance in her work.

The social worker is aided greatly in her work if she is also a trained nurse. She can then evaluate the conditions with a professional eye as well as with her social training and can thereby render a twofold service that is of special value.

In almost every instance it is best to tell the patient that he has cancer. This is now done in some hospitals doing cancer work and results in the best co-operation between the staff and the patients.

Should convalescent cancer patients, especially hopeless cases, be cared for in the hospital or in their homes? One large cancer hospital, the Memorial Hospital in New York, has answered this question by getting such patients out of the hospital at the earliest possible moment and back at home among friends and relatives. Here they are cared for by home visitors, trained nurses with experience in social work. These visitors render a splendid service by their regular visits to these patients at times only for a friendly call and again as nurses to render such professional care as is indicated. The medical staff of this hospital has repeatedly stated in public that it would never recommend special cancer work in any hospital unless and until such a follow up is available in the homes of its patients.

A MODERN MEDICAL AND SURGICAL CHEST SERVICE AT BARNES HOSPITAL

JACOB J. SINGER, M.D., St. Louis. That the medical and surgical chest service at Barnes Hospital was begun in a space formerly used as a storage room for trunks is ample evidence to prove that good work can be done with limited facilities as long as the personnel is properly trained and equipped.

Particular emphasis has been placed upon the study of the lungs in this department but the scope of thoracic surgery is by no means confined to these organs. Because of the development of safe surgical methods of approach and attack, not only do most types of the lung respond to surgical measures, but even intrathoracic tumors can now be safely removed and even certain conditions of the heart can be attacked successfully.

At the present time we have a large, well-ventilated, two operating rooms connected with the fluoroscopy room which is connected with the chest radiographic room. The rooms are wide enough so that a patient can be moved from the various rooms without having to be lifted and all necessary examinations and treatments made. A large right-angled room, used as a dressing room to and from the fluoroscopy room, has a large

boxes and stereoscopic apparatus the walls have moldings so that exhibitions of unusual chest photographs can be displayed for meetings and conventions. Private offices for the medical staff and secretary and a large classroom and dressing rooms complete the physical equipment.

The second floor of the new Rand Johnson Memorial Building of Barnes Hospital was set aside for patients requiring treatment in the thoracic field. This floor is connected by halls with the diagnostic service. It is modeled after the best tuberculous sanatoria with porch facilities for all patients. A graduate nurse especially trained in thoracic diseases, spends her entire time in the chest service and a secretary looks after records, lantern slides, and teaching paraphernalia both add greatly to the usefulness of this division for purposes of training and instruction. A special library in this field is rapidly becoming accumulated.

The chest floor in the Rand Johnson Memorial Building furnishes the best possible conditions for the care and treatment of chest patients. gives facilities for isolation is flexible so that the number of patients can readily and on short notice be increased or diminished is so arranged that patients desiring or needing accommodations varying from the free ward patient, ward pay patient, semi-private patient to the private patient can be received the time of the professional personnel including the visiting doctors, internes, nurses, dietitians, attendants, orderlies in fact all who come in contact with the patients, is conserved to the greatest possible extent.

DISEASE

LOUIS H. BURLINGHAM, M.D., St. Louis: Shall patients with tuberculosis be admitted to general hospitals? Outstanding authorities on tuberculosis are agreed that tuberculous patients should be ad-

mitted to general hospitals where provisions can be made for their care.

Sanatoria are often too far removed from large medical centers. Moreover the close connection of the large community hospital with teaching facilities makes it possible for future medical men to have the benefit of learning how to diagnose and treat such cases under discussion.

It is necessary for the general hospital to meet the advances made in thoracic work and to adopt the proper facilities in line with changing conditions.

EDITOR'S NOTE—Two afternoons during the Hospital Conference were devoted to round table conferences dealing with administrative, professional, economic, and social problems affecting hospitals. The Tuesday session was conducted by R. C. BURKE, M.D., Madison, Wisconsin, superintendent, State of Wisconsin General Hospital; the Wednesday session by ROBERT JOLLY, Houston, Texas, superintendent, Memorial Hospital.

Thursday, October 20, the closing day of the Hospital Conference, was given over to departmental demonstrations in the Jewish and St. Mary's Hospitals, conducted by the superintendents with heads of departments, and included the following demonstrations and discussions: preparedness for emergencies in hospitals; operating room management and procedure in handling major operations; food service with various types of tray set-ups; general and special or therapeutic diets; handling supplies; staff education and nurses conferences; organization of the hospital with exhibition of organization charts; admission of patients with complete procedure; nursing administration and nursing service problems associated with clinical records and complete record system; organization and management of the pediatric division with demonstration of certain procedures.

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PARTIAL PANCREATECTOMY IN CHRONIC SPONTANEOUS HYPOGLYCAEMIA

WITH A REVIEW OF THE CASES OF HYPOGLYCAEMIA SURGICALLY TREATED

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THE specific treatment of diabetes, or hypoinsulinism, with insulin has inevitably led to a knowledge of its counterpart hyperinsulinism. Indeed it is said that certain investigators long preceded Banting and Macleod in the discovery of a pancreatic substance so potent in its correction of diabetes that it had to be abandoned mainly because of the convulsive seizures that attended its administration.

Hyperinsulinism produces a train of symptoms, the severity of which is directly proportional to the insulin excess and the resulting hypoglycemia. Three surgical conditions have been recorded in the literature as being responsible for this insulin excess:

1. Metastasizing tumors or carcinomata of the islets of Langerhans which, contrary to the usual carcinoma of secreting glands, have retained their normal property of producing insulin.

2. A benign tumor or adenoma of the islets of Langerhans, comparable to an adenoma of the thyroid.

3. An overactivity of an otherwise normal appearing pancreas comparable, as pointed out by Wilder to hyperthyroidism due to hyperplasia.

Within the last 8 years all three conditions have been subjected to surgical intervention

with amelioration and, in a few cases, complete cure of the disease. The following brief summaries of these recorded surgical cases illustrate the characteristic symptoms accompanying this rather recently recognized clinical entity.

CASE 1 (Mayo Clinic.) Carcinoma of the islands of the pancreas. Hyperinsulinism and hypoglycemia. Wilder, Allan, Power, and Robertson. *J. Am. M. Ass.* 1927 lxxxix, 348.

A physician, aged 40, 18 months before admission to the Mayo Clinic began having sudden attacks of faintness and weakness, with parasthetic numbness of the tongue and lips. As time passed these attacks occurred more frequently and were more severe, producing greater weakness, profuse perspiration, and trembling. They came when meals were delayed or if unusual exertion was undertaken and the patient himself discovered that he could prevent them by eating between meals and by taking sweet drinks. The first attack resulting in collapse came in November 1925. The patient had been operating later than usual and, being overtaken by weariness, was soon mentally confused and collapsed in a stupor. Attendants thought he had lost consciousness, but he was able to swallow an egg nog which an assistant gave him and in a few minutes had completely revived.

As time passed, the tendency to hypoglycemia increased so that the interval between the patient's taking food had to be decreased and it became necessary for his wife to watch when the patient slept and put candy into his mouth at the first sign of unusual behavior. For the purpose of studying the hypoglycemic reaction, after the mixed noon meal

of October 31 sugar was withheld. The patient remained in bed under constant observation. The systolic blood pressure was 110 and the diastolic 60. The first symptoms appeared 3 hours and 30 minutes after the meal, when the blood sugar had fallen to 0.055 grams per 100 cubic centimeters. There was a sense of apprehension and depression with vague paresthesia. Fifteen minutes later perspiration and tremor were noted. At 4 hours this blood sugar had fallen to 0.036 grams per 100 cubic centimeters, the face twitched, speech was incoherent, and the systolic blood pressure was elevated to 134 while the diastolic remained at 60. At 4 hours and 15 minutes the blood sugar reached 0.027 grams per 100 cubic centimeters, the patient was stuporous and no longer able to speak, tossing about with irregular, convulsive jerking that affected the entire body. Fifteen grams of dextrose were fed by mouth, and in 10 minutes rational conversation was resumed. The blood sugar was 0.065, the systolic blood pressure was 122 and the diastolic 48.

In this instance the administration of epinephrin had little effect as compared with experience in other cases. One milligram of epinephrin was administered at a time when the patient was beginning to manifest symptoms of hypoglycemia and when the blood sugar was 31 milligrams per 100 cubic centimeters. The symptoms were not affected and sugar had to be given 4 minutes later to prevent collapse. Pituitrin injected when the blood sugar was low caused symptoms to appear and 40 minutes later a second injection was made. Sugar was required within 5 minutes after the second injection.

At operation, December 4, 1926 a hard firm nodular pancreas was felt and several nodules in the liver. At his death a month later a carcinoma of the islands of Langerhans with metastases to the liver was found. The carcinomatous tissue from the liver yielded at least 40 units of insulin for each 100 grams. It is of interest that before operation the ingestion of 20 grams of dextrose an hour was necessary to avoid symptoms of hypoglycemia, whereas just before death 1000 grams of sugar were required daily.

CASE 2 (Union Memorial Hospital, Baltimore.) Resection of the pancreas (Finney and Finney) Ann. Surg. 1928 lxxxviii, 584.

A woman aged 53 years, entered the hospital in December 1927 with the complaint of spells of confusion, with mental lapses and strange behavior. Her illness had begun 4 years previously coincident with her menopause. At first the attacks were slight and infrequent. It was noted that she would seem dazed, could not concentrate or think clearly and sometimes would see double. The attacks at that time would be of but a few minutes duration, with no after effects. After a year and a half, she became alarmed about her health, and went to Europe for a rest. During the year spent there, there were about six or eight attacks. They usually occurred before breakfast, but had not as yet come to be definitely associated with the taking of food. Any alarm or

trouble might precipitate an attack. Once or twice she fell while walking, but was conscious of no dizziness, and was able to arise immediately and continue. During the 18 months preceding admission the attacks had increased rapidly both in number and severity until they had become daily in occurrence, usually before breakfast.

A typical attack was described as follows: diplopia and great difficulty in properly focusing her eyes were often the initial symptoms. Then the head began to jerk unsteadily and roll from side to side. At the height of the attack, she screamed and threw herself violently about. There was at times some frothing at the mouth. There had never been any biting of the tongue, or other physical injury during an attack, nor any loss of sphincteric control. Everything that occurred during the attack was hardly remembered by the patient afterward. She felt exhausted, both mentally and physically. The attacks lasted from 15 minutes to several hours. Upon one occasion she said she was semi-conscious for a whole day. The most interesting feature about these attacks was that they were aborted in a few minutes if, at the first warning of their approach, the patient took a few mouthfuls of shredded wheat biscuit and cream. From September to December 1926, while under treatment at a sanatorium on forced feedings and bromides, she had no seizures at all.

A number of blood sugar estimations had been made during the period of her illness: September 1925 134 milligrams per 100 cubic centimeters; September 1926 41 milligrams per 100 cubic centimeters; October 1926, 79 milligrams per 100 cubic centimeters; May 1927, 30 milligrams per 100 cubic centimeters. The basal metabolic rate was -9 and -6 on two estimations. Other laboratory examinations were practically normal.

Ten units of insulin were given hypodermically with the immediate production of an attack. From this attack she recovered with equal rapidity following the intravenous injection of a glucose solution. On another occasion, 10 units of insulin were given intravenously together with 20 grams of glucose, without the production of an attack. At the time of these experiments, the blood sugar was at a normal level before the insulin was given. During the attack, it was very low from 20 to 30 milligrams per 100 cubic centimeters. Immediately after recovery following the injection of the glucose, it had again become normal. On the other hand, at another time while in the fasting state, with a very low blood sugar a hypodermic injection of 10 minims of adrenalin prevented the occurrence of an attack, and an hour later the blood sugar was found to be normal. The same result was obtained by the injection of pituitrin, hypodermically and, also though less promptly by the use of pituitrin intranasally. Epinephrin solution had no effect whatever in warding off an attack.

At operation, December 4, 1927 the pancreas and liver seemed normal in size, shape, and consistency.

Owing however, to the persistent unexplained hypoglycemia it was decided to resect a portion of the pancreas. Accordingly, beginning at the tail, the pancreas was mobilized and dissected out of its bed until approximately two thirds of it had been freed. When as much of the pancreas had been mobilized as it seemed wise to remove—approximately 22.5 grams—the body of the gland was divided by a V-shaped incision and the resulting flaps of pancreatic tissue were brought together and sutured with continuous plain catgut which effectually covered in all the raw surfaces and controlled the oozing therefrom. On microscopic section the removed tissue was apparently normal pancreas.

After operation the blood sugar varied from 45 to 70 milligrams per 100 cubic centimeters. From December 12 to December 20 the patient had light attacks almost daily usually the first thing in the morning occasionally at other times during the day. None of these attacks were severe nor did they progress beyond the point of uncomfortable sensations with a peculiar staring expression of the eyes, facial grimacing and general restlessness. At all times, the administration of a few drams of glucose immediately aborted an attack.

On the eighteenth day after operation there was a severe attack which subsided promptly on taking a few mouthfuls of shredded wheat sugar, and milk. It was followed by a crying spell, and the patient was very much depressed for the rest of the day. A venous puncture was done during the attack and the blood sugar was 30 milligrams. It would appear that not sufficient pancreas had been removed to control adequately the hyperinsulinism or a small adenoma had been overlooked.

CASE 3 (Stanford University Hospital.)

A man 31 years old entered the hospital on May 6, 1928 with the complaint of spells of unconsciousness. His past history was unimportant. His illness dated back one and a half years when on several occasions he was compelled to quit his work late in the morning because of pronounced weakness. He recalls one occasion when he became groggy but did not lose consciousness. About one year ago after a morning's work in the field and while returning to the house his legs became quite weak causing him to stagger. This was associated with mental confusion and disorientation followed by collapse and loss of consciousness. He was given a cup of hot chocolate following which he recovered immediately. Similar attacks occurred at infrequent intervals usually after several hours of hard work, and they were always relieved by taking food. On one occasion after attending a dance he failed to awaken in the morning and could be aroused only after food had been administered.

At the onset of the illness the attacks occurred at intervals of 1 to 2 months but after 4 months they occurred once in every 2 or 3 weeks. It was about this time that the patient associated the attacks with the need for food and thereafter he was able to abort or prevent them by eating. As time passed the at-

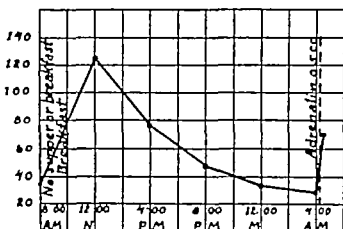


Fig. 1 The course of the blood sugar during a 20 hour fast. Supper was omitted the evening before with breakfast on the day of the fast. The vertical line represents the milligrams of sugar per 100 cubic centimeters of blood. Note that a blood sugar of 35 milligrams rose to 74 milligrams following the injection of 0.5 cubic centimeter of adrenalin.

tacks gradually became more severe and more frequent, and on one occasion while in Central America he was placed in a hospital under observation. Here he was told that he had convulsions accompanying the attacks. He returned to the United States and entered Lane Hospital for treatment.

The physical examination on admission revealed no abnormalities. The Wassermann reaction was negative. The gastric acidity as tested by the alcoholic meal was normal. The spinal fluid showed three cells, negative Nonne and Noguchi reactions, the colloidal gold curve was normal and the Wassermann positive in the first two dilutions. The basal metabolic rate was -20 per cent. In view of the patient's history it was decided to observe his reaction to starvation. He was deprived of his evening meal. The following morning at 8:30 he was quite pale sweating profusely, tossing about in bed, laughing giggling and talking incoherently. He refused to answer questions. The eyes were staring or tightly closed, the pupils were dilated the pulse was rapid but not alarmingly so. As he refused to eat an attempt was made to pass a stomach tube, against which he fought viciously. He was finally left to himself and about 3 hours later when his tray was brought he roused sufficiently to take nourishment and within 10 minutes he was again normal stating he remembered nothing of the morning's episode.

The blood sugar during the attack was found to be 38 milligrams per 100 cubic centimeters. The blood sugar was then determined at intervals of 4 hours over a period of 24 hours. The patient was deprived of supper the evening before and given only breakfast on the day of the test. The results are shown in Figure 1. On the morning of the test, after 20 hours of starvation the blood sugar was 36 milligrams per 100 cubic centimeters. At this time he was conscious but definitely confused mentally. Following breakfast he was perfectly normal and at

12 noon the blood sugar was 128 milligrams per 100 cubic centimeters. During the day the blood sugar gradually fell and at 4 a.m. he was unconscious, lying quietly in bed, sweating profusely pale, his eyes rolling aimlessly about. The blood sugar at this time was found to be 35 milligrams per 100 cubic centimeters. After 0.5 cubic centimeter of a 1:1000 dilution of adrenalin hydrochloride, he recovered almost immediately and a blood sugar taken at this time was found to be 71 milligrams per 100 cubic centimeters. Two days later a sugar tolerance test was made. The fasting blood sugar was 60 milligrams per 100 cubic centimeters. One hundred grams of glucose were given by mouth and at no time for the succeeding 3 hours did the blood sugar reach 100 milligrams per 100 cubic centimeters, remaining constantly at about 80 milligrams per 100 cubic centimeters.

The patient was placed on a quantitative diet with a glucose equivalent of 401 grams including intermediate nourishment at 10 a.m., 3 a.m. and 11 p.m. During the next 5 days he felt fine and had no attacks. While he was on this high carbohydrate diet blood sugar estimations were done over a period of 24 hours. In spite of the high caloric diet and the frequent feedings the blood sugar never reached 100 milligrams per 100 cubic centimeters and the morning blood sugar after 9 hours of fasting was only slightly above 50 milligrams per 100 cubic centimeters.

In view of the low basal metabolic rate the effect of thyroid extract was tried. He was given 5 grains of Armour's thyroid extract daily and at the end of 8 days the basal metabolic rate was -3 per cent. During this time he remained on the same quantitative diet equivalent to 401 grams of carbohydrate. A series of blood sugar estimations made at this time when compared with those prior to starting thyroid were slightly higher during the day but the net result during the early morning hours was practically the same. In view of the fact that there was no appreciable alteration in the blood sugar or general condition administration of thyroid was discontinued.

In view of the probability that this patient was suffering from hyperinsulinism due to a tumor of the islands of Langerhans (pancreas) he was advised to have an exploration of the abdomen, but this advice was refused and he was discharged from the hospital on May 28, 1928.

The patient remained at home for a month, and felt fine on a diet with a carbohydrate equivalent of 355 grams including nourishment upon retiring. At the end of this time he returned to work. On the morning of the third day he failed to awaken and was roused only after being given nourishment. From this time on he had frequent repeated attacks following the slightest physical exercise. After further consideration he finally consented to operation, and he again entered the hospital August 8, 1928.

A series of blood sugar determinations done after 3 days on the former diet with a carbohydrate equivalent of 401 grams were practically identical with those done on the previous entry. His hourly consumption of carbohydrate was determined before operation so that a postoperative hypoglycemia might be avoided. A duodenal tube was passed and at fluoroscopy 4 hours later the bucket was seen in the duodenum. He was given 25 grams of glucose per hour through the tube. A blood sugar determination at the end of 5 hours was 95 milligrams per 100 cubic centimeters, at the end of 9 hours it was 88 milligrams per 100 cubic centimeters. Apparently 25 grams per hour was just below his carbohydrate consumption.

A laparotomy performed by Holman on September 1, 1928, revealed a normal appearing stomach, liver and gall bladder. The pancreas was exposed by dividing the gastrocolic omentum. It appeared normal and, although quite firm, no masses or abnormal densities were encountered on palpation. It did not appear abnormally large. The inferior border of the tail and body were easily mobilized, but the splenic artery and vein along the upper border with their numerous tributaries entering the pancreas effectively prevented the freeing of the upper border. Accordingly the splenic vessels were deliberately included in mass ligatures placed through the pancreatic tissue about 8 centimeters apart, and the intervening pancreas was removed. If the opportunity to resect a pancreas again presents itself I should be tempted to mobilize the spleen and remove it together with the pancreas, thus permitting complete removal of the tail and as much of the body as was thought necessary without the necessity of saving the splenic artery and vein. The stumps of the pancreas were covered with adjacent peritoneal folds, the rent in the gastrocolic omentum sutured, and the abdomen closed in layers without drainage. During the operation 3,000 cubic centimeters of a 5 per cent glucose solution was administered subcutaneously and immediately after operation 500 cubic centimeters of a 5 per cent glucose solution was given intravenously.

Microscopic study of the pancreas revealed no obvious anatomical abnormalities.

The immediate postoperative course was uneventful. Immediately after operation the blood sugar measured 450 milligrams per 100 cubic centimeters with a rapid fall during the first few hours to 100 milligrams per 100 cubic centimeters. During the 4 days following operation it gradually fell to 80 milligrams per 100 cubic centimeters where it remained for about one week with another fall to 40 to 50 milligrams per 100 cubic centimeters. At this time he again began to have slight mental confusion. On the thirteenth day after operation he complained of a fullness in the abdomen, and 3 days later a mass appeared in the epigastrium which was thought to be a collection of pancreatic fluid. On September 22 the abdomen was reopened through the upper part of the previous operative wound and 1,500 cubic

The increasing literature on diabetes of the islands of Langerhans suggests that the proper name "pancreas" be used to designate the position of the pancreas.

centimeters of a thick grayish fluid removed contain numerous necrotic bits of tissue which microscopically proved to be pancreas. It was obvious that the pancreas included in the transfixion ligatures had been digested away thus increasing considerably the amount of pancreas removed. Five small cigarette drains were introduced into the cavity and the abdomen was closed. During the next few days there occurred a profuse drainage of thin fluid containing many bits of necrotic tissue. This drainage gradually lessened and he was discharged from the hospital on October 6.

Following the second operation the fasting blood sugar remained low and as he continued to be on the verge of a hypoglycemic reaction each morning it became necessary to give nourishment during the night. After his return home he continued to give evidence of a glyconic state in spite of nourishment during the night. On October 20 1928 a sugar tolerance test was again done and on comparing it with that before operation it was found that the blood sugar reached a higher peak but that at the end of 3 hours it was again back to 50 milligrams per 100 cubic centimeters.

The effect of pituitrin upon the blood sugar was then studied. A sugar tolerance was done in the same manner as before except that pituitary extract (B. W.) 0.5 cubic centimeter was given hypodermally 15 minutes after the 100 grams of glucose. In Figure 2 is plainly seen that the peak value is much higher but the fall more rapid so that at the end of 2 hours, 45 minutes the values are practically the same. He was then placed on pituitary extract (B. W.) 0.3 cubic centimeter 15 minutes after breakfast and dinner but as no beneficial effect on the blood sugar values resulted the pituitrin was soon discontinued.

Although complete relief from previous symptoms was not obtained immediately it was soon apparent that definite improvement had been effected. In April, 1929 he reported his hypoglycemic symptoms had been helped considerably. He was able to go through the day's work without leaving it to eat. In June, 1930, a series of tests at the Virginia Mason Hospital in Seattle showed the blood sugar at a higher level, and he reported himself much improved.

It is apparent, however that in a future comparable situation the removal of more pancreas would be indicated. A normal spleen is easily removed and to avoid any difficulties of hemorrhage from the splenic artery and vein, it would appear desirable to mobilize the spleen and the tail of the pancreas well up to the body making an attempt to reduce the size of the pancreas by two-thirds or three-fourths. If the analogy between hyperthyroidism and hyperinsulinism is applicable as suggested by Wilder, certainly a major por-

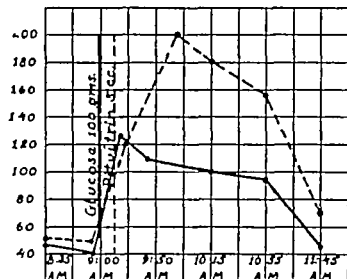


Fig. 2. Comparison of blood sugar curves after 100 grams of glucose with and without pituitrin. Solid line represents the blood sugar without pituitrin, the dotted line with pituitrin. The vertical line represents the milligrams of sugar per 100 cubic centimeters of blood.

tion of the pancreas must be removed to correct the hyperinsulinism. Moreover it would appear advisable also to introduce temporary drains to the operative bed to afford a removal of pancreatic secretion from the transfixed stump of pancreas, thus avoiding the complication experienced in this instance.

CASE 4 (Mayo Clinic.) Hyperinsulinism by Allan Arch. Int. Med., 1929 xlv, 65.

A farmer, aged 52 years, came to the Mayo Clinic in August 1928 because of attacks of weakness and stupor which had occurred at intervals for more than 2 years. On many occasions he had lost consciousness and had had convulsions. He noted that the attacks were most likely to occur if he had gone without food for several hours or if he undertook any exertion. He found that eating would relieve or prevent the symptoms, so he formed the habit of taking food at frequent intervals. As time went on the patient had to take larger amounts of food at shorter intervals. For several months before admission he had been obliged to eat at bedtime and during the night. He was unable to work, slight exertion, such as mowing his lawn, often precipitated attacks. Even when resting failure to take sufficient food resulted in attacks several times a week.

Investigation showed that when food was withheld, there was a gradual fall in the level of the blood sugar. If it fell below 0.06 per cent, the usual symptoms of hypoglycemia appeared. The lowest amount of blood sugar observed was 0.01 per cent. To prevent hypoglycemia food with the equivalent of 500 grams of dextrose each day was required, lunches being given between meals and three times during the night. The injection of epinephrin hydro-

chloride caused a rise in blood sugar and temporary relief of symptoms. Solution of pituitary had a similar influence although it was less powerful.

At operation, September 12 1938 the pancreas and neighboring organs appeared normal. The tail of the pancreas and part of the body were resected. The portion removed weighed 14 grams. Microscopic examination did not show visible abnormality.

Following operation, slight improvement was noted for a time, but in November, 1939, the patient described his condition as being similar to that before operation. He was obliged to eat regularly between meals, and once during the night.

CASE 5 (Toronto General Hospital.) Dysinsulinism. Convulsions and coma due to islet cell tumor of the pancreas, with operation and cure. Howland, Campbell, Maltby and Robinson J Am. M. Ass. 1929 xciii 674.

The patient, aged 52 years, complained in September 1922 of extreme exhaustion and attacks which were described as of minor and major character. Extreme faintness usually preceded the attack in which the patient became dazed, looked fatigued, and was restless. These minor attacks occurred so often at the table that it was suggested that the smell of food was a stimulus to insulin release. In the major attack, which might be preceded by diplopia or by a feeling of numbness in the legs, the mental confusion was deeper, she had to be placed in bed, where the grimacing became very evident. One could not arouse her although the eyes might be open, her appearance was in some degree similar to that of an intoxicated person. Then the convulsion would commence with violent kicking, and tossing about of the arms and body, there being excessive secretion of saliva and incontinence of urine and feces. No degree of stimulus appeared to rouse her until the onset of sweating and vomiting, and then, soaking wet with perspiration, the patient would return to consciousness. Occasionally the patient became drowsy and slipped quietly into a coma to wake up later without any realization of the lapse of time or of events taking place during the comatose period. Following two of the severe seizures, the left arm and leg became paretic and, while this lasted only a few hours in the first attack, in the later one it remained some days, associated with thick, slurring speech.

Complete neurological examination was always negative. The blood sugar during a typical attack ending in unconsciousness was 0.04 milligrams per 100 cubic centimeters, and prompt relief was obtained by the administration of dextrose intravenously. A high carbohydrate diet plus three fourths pound sugar daily was required to keep her in a normal state. Five cubic centimeters of epinephrin restored the blood sugar from 40 milligrams per 100 cubic centimeters of blood to 110 milligrams within one hour. Solution of pituitary administered at a time when the blood contained 195 milligrams of sugar per 100 cubic centimeters blood caused the sugar to drop to 145 milligrams per 100 cubic centimeters.

At operation in March, 1939, a small tumor 1.5 centimeters in diameter was removed from the midportion of the pancreas, which was without capsule, and composed of masses of epithelial cells of the islet of Langerhans type diagnosed as carcinoma. Insulin was recovered from this tissue. No attacks occurred subsequent to the operation and the patient was at least temporarily cured.

This case constitutes the first successful treatment of an adenocarcinoma of the islands of Langerhans recorded in the literature.

CASE 6. (Barnes Hospital, St. Louis.) Hyperinsulinism from B-cell adenoma of the pancreas. Carr, Parker, Grove, Fisher and Larimore. J Am. M. Ass. 1931 xcvi, 1363.

A youth, aged 19 years, entered the hospital January 1930, because of convulsive seizures diagnosed as epilepsy. About a year previously he had his first attack of unconsciousness in which his behavior was abnormal, and of which he remembered nothing. Other attacks followed at increasingly shorter intervals and became more profound and prolonged, and at the time of admission they were occurring almost daily, usually in the late morning, and especially during times of stress from school duties.

The attacks varied in severity but were essentially the same in character. They began with a feeling of queerness inside, a sense of hunger and anxiety. He became confused but would continue awkwardly in whatever he was doing. On one occasion, he drove for 45 minutes over busy city streets and had no remembrance of doing so. From confusion the attacks progressed into a stupor with profuse perspiration, slight cyanosis and, at times, more or less muscular movement. Recovery would occur spontaneously after a few hours and he was then tired and ravenously hungry. Food would promptly relieve the residual drowsiness. He had observed that an attack could often be aborted by eating candy and his mother had discovered that, if she could get him to take a few sips of sweetened tea at the onset of an attack, he would sometimes arouse sufficiently to finish the cup and the attack would be much milder. The anamnesis did not reveal any disorder of bodily functions between the attacks or otherwise during them.

Physical examination revealed normal condition in all essential details. During an attack of unconsciousness in the hospital, the blood sugar determination showed 44 milligrams per 100 cubic centimeters. Five grams of dextrose introduced intravenously brought a prompt return of consciousness. For a time a diet rich in carbohydrates caused almost complete relief of symptoms but by October a definite increase in severity of symptoms prompted surgical intervention. At the operation on October 23 1930, the pancreas was exposed through the gastrotomic omentum and revealed in its midportion a firm bluish mass 2 centimeters in diameter which

was easily enucleated. No leakage of pancreatic secretion occurred. Following operation the blood sugar determinations ranged from 107 to 92 milligrams per 100 cubic centimeters and no further attacks occurred. The tumor was composed of B cells of the island of Langerhans type.

CASE 7 (Barnes Hospital St. Louis.) Adenoma of the islands of Langerhans with hypoglycemia. Womack, Guagi and Graham. J. Am. M. Ass. 1931 xlvii 531.

A farmer aged 44 years one morning while doing chores before breakfast noted a mental confusion comparable to intoxication which was completely relieved by eating breakfast. A second similar attack a week later was followed by increasingly severe seizures resulting finally in periods of unconsciousness controlled completely by giving food. Various examinations were made and a tentative diagnosis of brain tumor suggested. The attacks then appeared before rising in the morning characterized by mental confusion talking at random and twitching movements especially about the face. Symptoms apparently referable to the gall bladder developed, for which the gall bladder and appendix were removed without relief. His wife then noted that repeated feedings during the night and the frequent ingestion of candy during the day prevented the attacks.

Physical examination was practically negative. The basal metabolic rate was +3 per cent. After 9 hours of fasting his blood sugar dropped to 50 milligrams per 100 cubic centimeters of blood. In this state his face was expressionless pupils dilated speech incoherent. One hundred and twenty grams of dextrose ingested by mouth restored him to a normal state. At the end of 7 hours he was again mentally confused. Epinephrin was administered and there was a temporary relief from the mental confusion with a definite rise in blood sugar. At operation February 4, 1931 a small tumor only 0.5 centimeter in diameter was excised from the pancreas and following the operation there were no further attacks. A 12 hour fast brought on no symptoms and his blood sugar did not fall below 90 milligrams per 100 cubic centimeters of blood. The tumor proved to be an adenoma of the islands of Langerhans.

CASE 8 (Mayo Clinic.) Hyperinsulinism. Report of two cases. Allan. Arch. Int. Med. 1929 xlv 65.

A man, aged 47 years was first seen in October 1928, 4 years after the onset of weakness and stupor which was followed by convulsive seizures, disturbances of sleep and somnambulism. He noticed that eating relieved the symptoms or checked the attacks so that he began to take food three times during the night as well as between meals. In spite of precautions attacks of weakness and stupor occurred with increasing frequency especially after exertion and he was obliged to give up his work. About 2 months before admission he was in a hospital where food was not given after 5:30 p.m. Attacks occurred

during the night in which he became irrational and maniacal so that he was confined in a straight jacket on several occasions. Recovery occurred spontaneously after several hours.

Examination of the blood showed that the sugar content fell when food was not taken sometimes reaching 0.04 per cent. Hypoglycemic symptoms usually appeared when the blood sugar fell below 0.05 per cent. The ingestion of food with the equivalent of from 400 to 450 grams of dextrose prevented hypoglycemic symptoms when given at suitable intervals. Epinephrin and solution of pituitary showed transitory effects in checking hypoglycemia. Ephedrin also appeared to have some influence. At the operation sometime after his first admission the pancreas appeared to be normal. A portion weighing 8 grams was excised. Microscopical examination did not disclose distinct changes in the islands. The level of blood sugar fluctuated and was not below normal until the fifth day when the administration of dextrose was delayed until 11:30 a.m. The blood sugar fell to 0.066. From this time on food was given three times during the day and three times during the night. It was apparent that the tendency to hypoglycemia had returned. Convalescence was satisfactory but it was necessary to continue the regular administration of food. The condition since has been about the same as it was before the operation.

CASE 9 (Pennsylvania Hospital, Philadelphia.) Adenoma of the islands of Langerhans with associated hypoglycemia. McClenahan and Norris. Am. J. M. Sc. 1929 clxxv 93.

A colored male of 41 was admitted to the hospital on December 15, 1927 with the complaint of attacks of loss of memory preceded for several months by a very queer feeling not accurately localized but apparently relieved by the ingestion of food. He was admitted in coma but within 1½ hours he had regained consciousness and was anxious to go home. A provisional diagnosis of epidemic encephalitis was made. Eleven hours after the usual hospital supper he was again in coma which continued until his death 70 hours after admission.

Three successive blood sugar estimations at 24 hour intervals were 40 milligrams per 100 cubic centimeters, 42 milligrams, and 38 milligrams in spite of the administration of glucose intravenously by gavage, and by rectum. The autopsy revealed a tumor of the midportion of the pancreas 15 by 7 by 16 millimeters in size, which had a delicate fibrous capsule, and the cells of which showed an alveolar arrangement, suggesting the adenomatous character of the lesion.

CASE 10 (Milwaukee County Hospital.) Carcinoma of the islands of the pancreas. Thalheimer and Murphy. J. Am. M. Ass. 1928 xci, 89.

A woman, aged 57 years, was admitted to the hospital in July 1927, in a stuporous state unable to answer questions but not unconscious. About 2½ years before admission she began to have attacks characterized by somnolence, followed by great

restlessness and irritability. The attack would last about one day, and on the following day she usually slept most of the time. In the beginning the attacks came at regular intervals, varying from 2 weeks to 3 months. During the last year they came more frequently and averaged about three a week until 1 month prior to entering the hospital, when she began to have them every day. For the past year epileptiform convulsions accompanied these attacks, but she did not foam at the mouth or completely lose consciousness during the attack.

After entrance to the hospital the patient remained in a semiconscious state most of the time. The seizures came regularly every forenoon about 9 o'clock. They were not severe and were not accompanied by stertorous breathing, unconsciousness, cyanosis, or foaming at the mouth. Usually the attack lasted from 30 minutes to 1 hour. Following this she slept for a few hours but could be aroused. Although she perspired mildly after the convulsions, it cannot be said that this was more than a minor symptom of the disease.

Blood sugar determinations on July 21 were 60.6 milligrams and on August 13, 33.5 milligrams per 100 cubic centimeters of blood. During the second week of August the convulsions came on about three times a day, following each attack the patient sank into a state of coma and slept several hours. She died on August 18 after a prolonged state of coma.

At necropsy the pancreas showed a small tumor 1.5 by 1 centimeter, located about 4 centimeters from the tail end, incompletely encapsulated and invading the surrounding pancreatic tissue. A diagnosis of arcuoma of the islands of Langerhans was made on the microscopic appearance.

It is apparent from the descriptions of the recorded cases that hyperinsulinism with its concomitant hypoglycemia is a recognizable clinical syndrome insidiously progressive in its course characterized by symptoms of weakness verging on exhaustion, nervous irritability and anxiety, easy fatigability, extreme hunger, muscular twitchings and tremors, imperfect and hazy vision, diplopia, unsteadiness of gait, excessive perspiration, loss of emotional control, proceeding in the more serious cases to mental confusion, disorientation, epileptiform attacks, convulsive seizures, syncope, semistuporous states, coma and finally death. These are the exact symptoms noted clinically due to an overdose of insulin and are directly commensurate with the resulting hypoglycemia. Patients themselves frequently discover the beneficent effects of food in averting attacks.

Hypoglycemia has been described in other conditions as well. Josephs and later Griffith

described a series of cases of convulsions in infancy and childhood which they attributed to hypoglycemia, the etiology of which they did not understand. In a case described by Griffith a boy of 4 months suffered repeated convulsions which recurred at irregular intervals until at the age of 2 years and 4 months, it was suggested that they resembled those found in hypoglycemia. At this time during an attack in which he became unconscious, febrile, spastic, and vomited, an examination of the blood sugar showed only 20 milligrams per 100 cubic centimeters of blood. An intravenous injection of 100 cubic centimeters of a 10 per cent solution of dextrose resulted in prompt and complete recovery from this attack as also in four other similar seizures.

Cambridge and Wagner and Parnas have described cases of spontaneous hypoglycemia which they thought were hepatic in origin and Harris and later Jonas called attention to a remarkably lowered blood sugar in certain patients complaining of gastro-intestinal symptoms, weakness, and extreme fatigue. Subsequently Gougerot and Peyre and Sen drall and Planques made similar reports. Hyperinsulinism or dysinsulinism was advanced as the cause of these symptoms, but it remained for Wilder and his associates (Case 1) to present pathological proof of the association between spontaneous hypoglycemia and hyperinsulinism.

It is possible that another explanation for hypoglycemia lies in the experience recorded by Wadl in which a typical case of Addison's disease with destruction of the entire suprarenal system was characterized by severe comatose attacks accompanied by a pronounced hypoglycemia. These attacks were for a time aborted by administration of glucose.

Nielsen and Eggleston recently described 3 cases of epileptiform seizures accompanied by a lowered blood sugar and an altered blood pressure in which great improvement was obtained by frequent feedings and the administration of desiccated whole suprarenal gland by mouth. Frequent feedings alone did not work as well as when combined with the suprarenal gland. They postulated a dysinsulinism or hyposuprarenalism as the probable causative factors.

Several years ago a condition of hypoglycæmia was demonstrated 18 hours following subtotal thyroidectomy for Graves' disease (5, 8). An antagonism between thyroxin and insulin has been hinted at by various writers, and it is suggested that the removal of a hyperactive thyroid gland results in a temporary overaction of its antagonist the pancreas. However, the interrelationship of the thyroid, adrenal, pituitary, and pancreatic glands is so intimate and the mechanism of their interactions with reference to sugar metabolism so obscure, that one can do little but theorize, and that not very intelligently. For the moment one can simply present the facts in the hope that they can be pieced together subsequently.

In the three instances in which small adenomata were removed at operation with complete recovery, one is surprised to find how small these tumors actually were. In the two cases from the Barnes Hospital Cases 6 and 7 the first tumor measured 2 centimeters in diameter, and the second only 0.5 centimeter in diameter. The case from the Toronto General Hospital yielded a carcinomatous tumor only 1.5 centimeters in diameter. Two other instances in which proved hypoglycæmia existed before death Cases 9 and 10 yielded tumors only 1.5 centimeters in diameter. Shields Warren records 4 instances of so called adenomata of the islands of Langerhans found incidentally at necropsy measuring 1.7 millimeters, 1.3 millimeters, 1.2 millimeters, and 9 millimeters in diameter, respectively. These patients all died of other causes and gave no recognizable clinical evidence of hypoglycæmia.

It is highly probable that in the 4 patients operated upon by resection of portions of the pancreas without conspicuous improvement in symptoms (Cases 2, 3, 4, 8) small adenomata in the remaining pancreas may well have been overlooked. When operation is done for hypoglycæmia careful palpation and inspection of the body and tail of the pancreas is indicated to detect the comparatively small tumors that could account for the clinical symptoms. If such a search is fruitless it would appear necessary to mobilize the pancreas fairly completely and to remove at least

four fifths of the gland. Mobilization of the pancreas could be facilitated markedly by removing the spleen with it thus obviating the necessity of ligating the innumerable tributaries of the splenic artery and vein which course along the upper border of the pancreas.

SUMMARY

Hyperinsulinism with its resulting hypoglycæmia produces symptoms of weakness verging on exhaustion, mental confusion, disorientation, epileptiform attacks, convulsive seizures, syncope, unconsciousness, coma and death. Clinically and anatomically it has been demonstrated in connection with carcinoma of the islands of Langerhans, adenoma of the islands of Langerhans, and hyperplasia of the pancreas. The last condition is still purely hypothetical and it may ultimately be found that the hypoglycæmia in similar cases is dependent not upon simple hyperplasia of the gland but upon small adenomata embedded in the gland and therefore not easily demonstrable at operation. The presence of such small adenomata should, however, be carefully sought for in any case operated upon for spontaneous hypoglycæmia before resorting to partial pancreatectomy. Case 3 is presented as the second instance of spontaneous hypoglycæmia due presumably to simple hyperplasia of the pancreas, improved by partial resection of the pancreas.

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THE INFLUENCE OF ENDOMETRIUM UPON THE RABBIT OVARY AFTER HYSTERECTOMY

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IT is a generally accepted clinical observation that hysterectomy even with the conservation of one or both ovaries hastens the onset of symptoms of the menopause. A second clinical observation is that these symptoms are less likely to develop if the amputation is performed high enough to insure the retention of sufficient endometrium to permit at least a scanty menstruation. These two observations have led to the theory that the endometrium produces a hormone essential to the normal functioning of the ovary; its removal disturbs the normal endocrine activity of the latter organ which dysfunction in turn is responsible for the early onset of the menopause. In the present experimental investigation, an attempt has been made to find out whether the endometrium is essential to the normal functioning of the ovary.

Dysfunction of the ovary following hysterectomy can be studied indirectly from the anatomical point of view. Little knowledge is available regarding the structure of the human ovary permitted to remain *in situ* for a considerable period of time following operation. Though such ovaries have been examined none has been studied in serial section consequently until an adequate number of these studies are made, the histological picture of the ovary after hysterectomy will be understood best by a study of serial sections of the animal ovary.

The present experimental investigation concerns the gross and microscopical structure of the rabbit ovary removed some months fol-

lowing hysterectomy and is based upon observations on 32 animals. Endometrium was autotransplanted in half of these at the time hysterectomy was performed.

The object of the study was to determine first if structural changes occur in the ovary of the rabbit as a result of hysterectomy second, if so their nature, and third whether loss of endometrium is a factor in bringing about these changes.

REVIEW OF LITERATURE

Human ovary after hysterectomy. Twenty two reports were studied which dealt with the condition of human ovaries removed some weeks, months or years following hysterectomy (1-5 7-14 17 21 23-26 31 32 35). Among the gross pathological changes, cysts were noted by ten observers and atrophy by five. These were the only gross findings common to any two reports. Eight of the 22 authors reported microscopic findings. Five of the 8 observed nothing abnormal (3 8 9 11, 17) of the other 3 Hawks and Vineberg observed cystic changes and Werth reported the presence of large follicles and the absence of ova.

These statistics are probably misleading with respect to the frequency with which abnormal developments occur in conserved ovaries, as obviously few ovaries which are normal and hence produce no trouble are removed at a second operation.

Animal ovary after hysterectomy. Of 19 studies dealing with the anatomy of the animal ovary 17 included microscopic examina-

tion In 6 of the 17 studies, the ovaries were described as being microscopically normal, in the remaining 11, alterations were observed Schubert saw no ova, Lindig observed dilated follicles, Terada found follicular atresia, Keitler and Jacobsohn noted a smaller number of follicles than normally while Loeb and Takakusu both described large corpora lutea, which were believed to have resulted from an inhibition of the regressive power of these bodies. Degenerative changes were observed in four experiments (18 22 33 34) but in only two were cysts found (19 27)

Human ovary after hysterectomy and uterine transplantation Three reports concerned the transplantation of human uteri or portions of endometrium at the time of hysterectomy, but gave no later description of the ovaries (28, 33 34)

Animal ovary after hysterectomy and uterine transplantation Four previous workers reported the results of their efforts to influence ovarian function experimentally by means of uterine transplantation Schubert transplanted the whole uterus of a goat with no resulting effect upon the estrous cycle Zimmermann (33, 34) transplanted pieces of endometrium into the abdominal wall in hysterectomized rabbits, and found that regressive changes in the retained ovary were inhibited as long as sufficient uterine tissue remained viable Takakusu transplanted portions of uterus into the abdominal wall of one series of rats at the time of hysterectomy, and of a second series of these animals 3 or 4 weeks after hysterectomy The ovaries of the group submitted to an immediate transplant were found subsequently to be more nearly normal in microscopical appearance, than those from the group submitted to transplantation 3 to 4 weeks after their hysterectomy was performed Parfenoff, using a single series of mice, found that hysterectomy without endometrial transplantation produced follicular atrophy With the use of endometrial transplants into the abdominal wall, he was able to stimulate the growth of new follicles and fresh corpora lutea.

EXPERIMENTS

Materials and methods Sixty four adult rabbits (8 pregnant, 26 exhibiting varying

degrees of heat, and 30 not in heat), were subjected to hysterectomy, half of the group receiving, simultaneously, autotransplants of endometrium in the abdominal wall The operations were conducted under either ether inhalation anesthesia or following the intraperitoneal injection of a watery solution of "amytal" (iso-amyl-ethyl barbituric acid) In each instance, the entire uterus was removed, including the upper half of the vagina and the portion of each oviduct next to the uterus Three pieces of endometrium, approximately 3 to 4 millimeters in largest diameter, were then placed in a pocket in each rectus abdominis muscle During the operation, touching of the ovaries or traction on the mesovarium was avoided The animals were isolated during the period of wound healing after which they were herded together until sacrificed

During the interval between operation and sacrifice, no attempt was made to test ovarian function by the willingness of the female to accept the male. Since the rabbit ovulates only at the time of copulation or of other sexual excitement, as when one female in heat covers another, had copulation been permitted and had it occurred in some cases only, it would have injected a variation into the fol-
licular picture presented by the entire group

Of the original 64 animals operated upon 52, divided equally between the transplant and the non transplant groups, lived 6 months All were killed by chloroform inhalation 30 at the end of 6 months, and 3 months later, or 9 months following hysterectomy, the 13 remaining were sacrificed The gross appearance of the ovaries and transplants was recorded and both were prepared for sectioning, Susa fixation being used For control purposes, ovaries were removed from 13 non hysterectomized adult rabbits which were definitely not in heat

RESULTS

Classification of ovaries The ovaries fell readily into 3 treatment groups Group I, ovaries from control animals (non-treatment group) Group II, ovaries from animals subjected to a simultaneous hysterectomy and autotransplantation of endometrium (trans-

TABLE 1—NUMBER OF SECONDARY FOLLICLES

Group	Serial number	Weights		Secondary follicles Number
		Rabbit kgms.	Ovary mgms.	
I Control	C	6	90	86
	F	8	83	70
	L	7	78	30
	O	4	66	51
	Q	3.5	60	77
	Average	9	9	99
II Transplant	B 7			73
	B 9		85	70
	B		30	74
	B	3.5	30	64
	B 14		90	
	Average	3.76		69.8
III Non Transplant	A 5	3	90	34
	A	2.6	80	30
	A 8	2.4	80	59
	A 4	3	83	44
	A	1.6	100	60
	Average	2.7	87	57

Showing: a. the number of secondary follicles by actual count, 0.25 millimeter or more in diameter observed in (I) 5 control ovaries, (II) 5 ovaries from animals subjected 6 months previously to a simultaneous hysterectomy and autotransplantation of endometrium, and (III) 5 ovaries from animals subjected to hysterectomy without transplantation of endometrium, together with (b) the weights of the animals and (c) the weights of the ovaries which contained the counted follicles. Note that, on the average, the operated upon animals (Groups II and III) possessed fewer secondary follicles than the control animals (Group I) and that the animals subjected to a transplantation of endometrium (Group II) possessed a larger number of secondary follicles than the ones subjected to the hysterectomy without the transplantation of endometrium (Group III). Also observe that the average weights of the ovaries in the different groups did not vary proportionally with the number of follicles in the same groups.

plant group) Group III, ovaries from rabbits subjected to a hysterectomy without an autotransplantation of endometrium (non-transplant group)

Gross appearance of ovaries The ovaries of the 52 animals operated upon (Groups II and III) were in the resting state. Whether this uniform condition was a sequel of the hysterectomy or due to other circumstances, cannot be stated.

The ovaries of 49 of the 52 rabbits were grossly normal. The remaining animals ex-

hibited one normal and one abnormal ovary apiece. In each case, the latter ovary formed part of a mass composed chiefly of oviduct distended with clear fluid, apparently due to blocking of the uterine end by a ligature. In these three instances, the ovaries were thinned out and their outlines were very indefinite. In no case did the ovaries of the animals operated upon exhibit grossly either signs of atrophy or of cyst formation other than that mentioned above.

Twenty six ovaries from the non-treatment group (I), 50 from the transplant group (II) and 51 from the non-transplant group (III) were weighed and measured. There were no significant differences in the size or weight of any of these ovaries.

Gross appearance of transplants Each of the 36 animals which received autotransplants of endometrium when killed possessed at least one piece of engrafted tissue of considerable size. In 20 cases, bilateral transplants were present, in the remaining 6 only a single one. The transplants were multilocular cysts, the largest of which reached a diameter of 25 millimeters. In animals killed 6 months after operation the transplants were slightly larger on the average than those in animals killed 9 months after operation.

After they had remained in fixative for some time, the transplants were bisected. The majority contained clear fluid others possessed a yellow or white granular material and in one or two a gelatinous substance was present. One transplant from each of 20 of the animals was studied microscopically half of each one was cut serially in sections 6 micra thick and each fiftieth section was examined. These transplants were removed from the 20 animals whose ovaries were studied microscopically.

Microscopical appearance of transplants In 18 of the 20 transplants (Fig. 1), the cells lining the cysts varied in shape some were ciliated though the majority were not. Most of them were normal in appearance, only a few exhibited degeneration, which was extensive in only 2 cases. The degenerated cells desquamated and were found suspended in the liquor which filled the cyst cavities. In 2 cases the cells lining the cysts dipped into

the underlying tissue, forming structures similar to the small uterine glands (Fig 2)

The tunica propria, which was composed of a loose sheet of typical fibroblasts varied greatly in thickness. It was rich in blood vessels and poor in lymphocytes and leucocytes. Bundles of involuntary muscle fibers were characteristic of most of the transplants, in some cases forming a dense sheath.

Two of the 20 transplants were in the process of degeneration, in them the cyst cavity was narrow. The epithelial lining was almost absent, and the tunica propria also showed signs of degeneration. This was associated with hemorrhage and an invasion of leucocytes and lymphocytes.

Microscopic appearance of ovaries Microscopic study of the ovaries included (1) a count of the secondary follicles (those above 0.25 millimeter in diameter and with cavity formation), (2) measurement of the largest diameter of each, (3) an estimation of the number of primary follicles, (4) the frequency with which atresia occurred, and (5) the condition of the remaining tissues in the organ.

One ovary selected at random from each of 19 non-transplant, 20 transplant and 7 control animals, was cut parallel to its long axis, in serial sections 6 micra thick which were stained with hematoxylin-eosin.

Number of secondary follicles The secondary follicles in 15 ovaries which included 5 from control animals and 10 from the transplant and the non-transplant groups were counted in the following manner. Each sixth section in its entirety, was projected on paper at a magnification of 20 diameters outlined in pencil, and each secondary follicle, with an outside diameter of 5 millimeters or more when projected, was also outlined. This minimum follicle size was selected arbitrarily in view of the difficulty of measuring accurately projected follicles of a lesser diameter. The first section of each follicle to appear was given an identification number, which it retained as its subsequent sections reappeared on other slides.

The number of these secondary follicles in the 15 ovaries, together with the weights of the animals and of the ovaries which contained the counted follicles, are recorded in

TABLE II—NUMBER OF SECONDARY FOLLICLES IN RABBIT OVARY AFTER HYSTERECTOMY

Treatment group	Group A			Group B	
	N. of animals	Follicles		N. of animal	Follicles
		Actual count	Average estimated ratio		Average estimated ratio
I Control	5	90.0	83.8	5	113.5
II Transplant	5	60.8	66.8	13	50.0
III Non-transplant	5	51.2	42.8	15	37.0

Showing the results of 3 methods for establishing the ratios between the number of secondary follicles (those with cavity formation) in one ovary from each of (I) 5 control animals, (II) 5 subjected to simultaneous hysterectomy and autotransplantation of endometrium, and (III) 5 subjected to hysterectomy without transplantation of endometrium. The average number of secondary follicles (.25 millimeter or more in diameter) by actual count is recorded for the 5 ovaries (Group A) in each of the three treatment groups and the average of the total number of sections of all follicles seen in each sixtieth section of each of the same ovaries is also shown (Group A). Contrasted with these, are the averages of the total number of sections of all follicles seen in each sixtieth section of 31 additional ovaries (Group B). Note that the averages of the estimated ratios between the numbers of sections of secondary follicles in Groups A and B in the three treatment groups are relatively consistent with the averages of the actual counts of the follicles in Group A.

Table I The ovaries of the animals subjected to a simple hysterectomy (Table I, Group III), exhibited approximately half the number of follicles possessed by the control series (Table I, Group I), though the weights of the ovaries in these two groups were approximately the same. The ovaries of the transplant group (Table I, Group II) possessed a follicular count midway between those of the controls (Group I) and of the non-transplant animals (Group III). Significant differences seemed to exist between the actual number of secondary follicles in these three groups of ovaries as shown numerically in Table I and graphically in Figure 3.

The relative number of secondary follicles in the three treatment groups was arrived at in another manner. The number of sections of secondary follicles present in each sixtieth section of each of the 15 ovaries was counted. The total of these sections in all of the sixtieth sections of each ovary gave a relative figure but not an absolute one, for the number of follicles present. The average of these estimations for the 3 treatment groups of ovaries

TABLE III.—NUMBER OF NORMAL PRIMARY FOLLICLES AND ATRETIC PRIMARY AND SECONDARY FOLLICLES

Condition of follicles	Ovaries showing many follicles		
	7 control Per cent	19 non-transplant Per cent	20 trans-plant Per cent
Normal	100	63	40
Atretic	100	35	74

Showing the estimated relative number of (a) normal primary follicles and (b) atretic primary and secondary follicles in one ovary from each of (1) 7 control animals, (2) 19 animals subjected to a hysterectomy 6 months previously and (3) 20 animals subjected to a simultaneous hysterectomy and autotransplantation of endometrium, also 6 months previously. The number of normal and atretic follicles is expressed as the percentages of the number of ovaries which possessed many as compared with few of these follicles, on the basis that 100 per cent of the control ovaries possessed many normal primary follicles, and many atretic primary and secondary follicles. Note the decreased percentages of ovaries of the two groups operated upon which possessed many normal primary follicles and the increased percentages of ovaries in both groups operated upon, which exhibited many atretic follicles. In other words, the animals operated upon possessed fewer normal primary follicles and more atretic primary and secondary follicles than did the ovaries of the control animals.

is recorded in Table II. The ratio between these estimated averages (Table II Group A) was found to be consistent with the ratios observed between the actual counts of the follicles in the same ovaries (Table II Group A). Since this shorter method of estimating the relative number of follicles in the 3 treatment groups gave results which were consistent with those secured by actual count, it was used in determining the relative number of follicles in the ovaries of 31 additional rabbits (Table II Group B). The constant relation between the actual count of the follicles in Group A, and the estimations of their numbers in Groups A and B emphasizes the constancy of the differences in the numbers of follicles in the control, transplant and non transplant groups.

Size of secondary follicles. The size of each secondary follicle in the 15 ovaries (Table I and Table II Group A) was recorded in terms of its maximum diameter. It was found that the follicles in the ovaries of both groups of animals operated upon reached the same ultimate size as did those in the control group.

From this observation it is concluded that growth of the measured secondary follicles, in the ovaries of animals operated upon, was not interfered with by removal of their uterus. This fact is of interest in view of the small number of follicles found after hysterectomy.

Number of primary follicles. The number of primary follicles was not counted but only estimated. The ovaries of the control animals possessed either a continuous layer of primary follicles in the cortex or occasional interruptions in this layer of follicles, which were also noted in the ovaries of some of the animals operated upon. Such ovaries were described as possessing many primary follicles. In case larger gaps existed in the layer of primary follicles in the ovaries of animals operated upon or if the follicles appeared only in scattered groups, these ovaries were described as possessing few follicles.

Comparing the percentages of ovaries in the three treatment groups which presented many in contrast to few normal primary follicles (Table III) it becomes evident that in the 2 groups operated upon (II and III) there were fewer ovaries containing many primary follicles. In other words, the ovaries of the animals operated upon (Groups II and III) possessed fewer primary follicles than did those of the control animals (Group I). The question whether this marked difference was due (1) to failure of the primary follicles to form or (2) to the early degeneration of a large number of them will be discussed later.

Atresia. The ovaries of control and operated upon animals possessed varying numbers of atretic primary and secondary follicles. These were not counted but only estimated. Where they were more numerous, the term many atretic follicles was used where less frequent, the term few. The number of ovaries (expressed in percentages) of animals operated upon which exhibited many atretic primary and secondary follicles is recorded in Table III on the basis that 100 per cent of the control ovaries possessed many of these follicles. It will be noted that atresia was observed more frequently in the ovaries of the animals operated upon than in the controls and also that transplantation of endometrium appeared to lessen the amount of atresia.

TABLE IV—AMOUNT OF STROMA

Stroma	Ovaries		
	7 control Per cent	19 auto- transplant Per cent	20 trans- plant Per cent
Well developed	100	53	75

Showing the frequency with which well developed stroma was observed in one ovary from each of (1) 7 control rabbits, (2) 19 subjected to a hysterectomy 6 months previously and (3) 20 animals subjected to a simultaneous hysterectomy and autotransplantation of endometrium also 6 months before. The amount of stroma is expressed as the percentage of ovaries which possessed a well developed stroma, as compared with those which had a poorly developed stroma on the basis that 100 per cent of the control ovaries possessed a well developed stroma. It will be noted that more of the ovaries of the 20 animals subjected to a simultaneous hysterectomy and autotransplantation of endometrium exhibited well developed stroma than did the ovaries of the 19 animals subjected to hysterectomy without autotransplantation of endometrium.

Germinal epithelium The histological picture of the germinal epithelium of the groups operated upon was identical with that of the controls.

Stroma In the ovaries of the control animals, the amount of stroma its distribution and structure, with one exception were found to be uniform (well developed). The larger blood vessels were surrounded with abundant connective tissue, which followed the smaller ones into the cortex and distinct septa of connective tissue were present between the different sized groups of interstitial cells.

In the exception just mentioned the connective tissue formed a sheath of only medium thickness around the larger vessels and the septa between the groups of interstitial cells were also more delicate. The term "moderately developed" stroma was applied to this case. This type of stroma was observed in quite a large number of the ovaries of the animals operated upon. In the cases in which the connective tissue septa in some ovaries were almost entirely absent, and the vessels were surrounded with only a thin layer of connective tissue the stroma was termed poorly developed.

The number of ovaries (expressed in percentages) in the different groups, which possessed a well developed stroma is shown in Table IV. These figures are based on the finding that 100 per cent of the control ovaries

TABLE V—AMOUNT OF INTERSTITIAL

Tissue	Ovaries		
	7 control Per cent	19 auto- transplant Per cent	20 trans- plant Per cent
Much	100	107	90

Showing the estimated amount of interstitial tissue in one ovary from each of (1) 7 control animals, (2) 19 animals subjected to a hysterectomy 6 months previously and (3) 20 animals subjected to a simultaneous hysterectomy and an autotransplantation of endometrium also 6 months previously.

The amount of interstitial tissue is expressed as the percentage of ovaries which possessed much tissue in contrast to the percentage which possessed a moderate amount, on the basis that 100 per cent of the control ovaries possessed much interstitial tissue. Note that the ovaries of the 2 groups of operated upon animals possessed approximately the same amount of interstitial tissue as those of the control animals.

possessed a well developed stroma. It is evident (1) that more control animals exhibited a well developed stroma than did the animals operated upon and (2) that the stroma was better developed in the ovaries of the transplant group than in those of the non transplant group.

Interstitial tissue The amount of interstitial tissue was found to be approximately the same in the ovaries of control animals and animals operated upon (Table V). The interstitial cells, however, varied in size, shape, and structure. Four types connected with transitional forms were observed (Table VI).

Type I This cell small, polygonal in shape, its nucleus about the size of a red corpuscle, was surrounded with a narrow layer of cytoplasm, which was usually shrunken. If properly preserved and stained, it was slightly granular and neutral in its reaction to the stains.

Type II The nucleus of this type of cell was polygonal and slightly larger than that of Type I, its cytoplasm was abundant and contained granules which showed a strong affinity for the acid dye. It contained vacuoles of varying sizes, the largest sometimes the size of its nucleus.

Type III The cells of this type resembled those of Type II. However, the individual cell and its vacuoles were considerably larger than those of Type II.

TABLE VI—TYPES OF INTERSTITIAL CELLS

Cells	Ovaries		
	7 control Per cent	10 non- transplant Per cent	10 trans- plant Per cent
Type I Follicular, or equal to Type II	100		45
Type II Follicular, or equal to Type I	00	45	4
Type III Mass Abundant	7 100	4	15
Type IV Mass Abundant			5

Showing the frequency with which four types of interstitial cells were observed in one ovary from each of (1) 7 control rabbits, 2) 10 animals subjected to a hysterectomy 6 months previously, and (3) 10 animals which at the same time were subjected to simultaneous hysterectomy and autotransplantation of endometrium. The number of cells of each type is expressed as the percentage of ovaries which possessed the type of cells recorded in the left column, on the basis that 100 per cent of the control ovaries possessed approximately equal numbers of cells of Types I and II. Note that both groups of animals operated upon possessed fewer of the cells of Types I and II, and that the cells of Type I were seen more frequently in the ovaries of the transplant group than in those of the non-transplant group.

Type II. These cells looked like fat cells. They were large round and contained a few large vacuoles or perhaps only one and some remnants of granular cytoplasm.

In spite of these dissimilarities, these four types of cell appear to be true interstitial cells. Their differences might be explained on one of two assumptions. Either they represent cells which are functioning differently or they are steps in a slow but progressive form of degeneration.

DEDUCTIONS FROM EXPERIMENTS

Although scattered data have appeared in the literature concerning the influence of hysterectomy (upon both humans and animals) in producing cysts in ovaries which have been left *in situ* following this operation, our large number of experiments gave no evidence that this is so in the case of the rabbit. From our observations we conclude that loss of endometrium plays no rôle in the production of ovarian cysts in the rabbit.

Endometrial autotransplants appear to grow readily for a short time in the abdominal

wall of the rabbit. Ultimately, however they lose their typical structure, and become cystic. In view of the several histological differences between the ovaries of the animals which received transplants and those which did not, it would appear that the transplants functioned for a while at least. In this connection it must be remembered that transplanted endometrium even if entirely healthy is less in amount than in the normal animal. Consequently if inhibiting or degenerative changes in ovaries result from removal of all endometrium, these same changes, to a lesser extent, might be expected in all transplant cases, especially in those in which the transplant failed to grow or later atrophied.

It is also quite likely that the endometrium left after high amputation of the human uterus is less subject to degenerative changes than that transplanted into the rectus muscle of the rabbit. Obviously then, the ovaries remaining in the human being which retained high cervical endometrium would be less likely to exhibit inhibiting or degenerative changes than would those in animals whose only endometrial tissue was in the rectus muscle.

The decreased number of primary and secondary follicles observed in the two groups of operated upon animals raises the question of the manner in which these decreases were brought about. It is possible that the reduction in the number was due to (1) an inhibition of formation of new follicles, or (2) a degeneration of existing follicles, or (3) a combination of the two. The small number of primary follicles in the cortex of the ovaries of the animals operated upon suggests that fewer of them formed than normally while the increased number of atretic primary and early secondary follicles indicates that many follicles failed to develop normally. Atresia of primary and of small secondary follicles was more frequent than in the case of the larger secondary follicles. In view of these observations, and because the larger follicles of control animals and those operated upon all reached the same ultimate size, it would seem that the hysterectomy influenced chiefly the primary and the smaller secondary follicles, and that it acted mainly by inhibiting the formation of new



Fig. 1. Showing wall of typical endometrial cyst resulting from autotransplantation of endometrium into rectus abdominis muscle of rabbit when hysterectomy was performed 6 months previously. A Epithelial lining of cyst B tunica propria containing several gland like structures C smooth muscle fibers, probably uterine in origin D cyst capsule E rectus abdominis muscle. $\times 75$

follicles since the absence of primary follicles in the cortex was more evident in most of the ovaries than was the presence of an undue amount of atresia.

The germinal epithelium presented nothing unusual from the anatomical point of view. The significant decrease in the estimated number of primary follicles in the ovaries of the animals operated upon and the actual decrease (40 per cent) in the number of counted secondary follicles however suggests that the operation must have influenced this tissue functionally even if there was no observable anatomical alteration.

No evidence from the experience of others has been found which indicates that the stroma of the ovary is influenced by the action of any hormone, or that the connective tissue of any other organ is similarly affected (6). On the contrary, our findings point to (1) a definite difference in the amounts of stroma in operated upon and control animals, and (2) a difference in the amount of stroma in the transplant group as compared with the non transplant group. From these observations it might be concluded that the stroma is influenced by loss of the uterus and therefore that it is affected by hormones.

The interstitial tissue appeared to be constant in amount in the ovaries of both the operated upon and the control animals. Its amount therefore, does not seem to have any



Fig. 2. Showing an endometrium-like structure which projected into the cavity of a cyst, resulting from the autotransplantation of endometrium into the rectus abdominis muscle of a rabbit when hysterectomy was performed 6 months previously. Note the ciliated epithelium on the surface and beneath it the numerous endometrium like glandular structures.

direct or appreciable relation to loss of endometrium.

In the control ovaries the more normal types of cells (I and II) predominated (Table VI), and though those of Type III were seen, the cells of Type IV were absent. In the ovaries of the non transplant group, the Type II cells were observed more frequently than in the transplant group. This indicates a shifting from the normal type of cell, following hysterectomy, to that of the cell which was either functionally different or degenerating according to the interpretation of the change. Since the cells of Type I were found more frequently in the transplant group than in the non transplant group the conclusion may be drawn that the presence of the transplant tended to check the shifting process from Type I toward IV. The reason for this difference cannot be stated though it might be assumed that the presence of the endometrium was a factor.

The arrangement of the cells of Type III in clusters of various sizes, suggests that these cells might have been mistaken by other observers for degenerating corpora lutea. How

SUMMARY

1 Observations are recorded upon (a) the gross and microscopical appearance of the ovaries of 26 rabbits which were subjected to a hysterectomy 6 months or more previously and upon (b) 26 which were subjected to a simultaneous hysterectomy and autotransplantation of endometrium.

2 The ovaries of both groups of hysterectomized animals exhibited grossly no significant differences from the ovaries of control (unoperated upon) animals, except that none of them showed any signs of follicular activity characteristic of estrus.

3 Microscopically the ovaries of the hysterectomized animals differed from those of control (unoperated upon) animals by possessing (a) fewer primary and secondary follicles (b) more atretic follicles, chiefly primary (c) less stroma (d) more atypical interstitial cells.

4 In comparison with the ovaries of the animals subjected solely to a hysterectomy the ovaries of animals subjected to a simultaneous hysterectomy and autotransplantation of endometrium microscopically exhibited (a) more secondary follicles (b) fewer atretic follicles, (c) more stroma (d) a healthier type of interstitial tissue.

CONCLUSIONS

1 Hysterectomy upon the rabbit (a) inhibits the development of estrus and (b) brings about changes in the microscopic structure of the remaining ovaries which tend to be both inhibitory and degenerative in nature.

2 Autotransplantation of endometrium has a tendency to limit the extent of the inhibitory and degenerative changes which result from hysterectomy.

3 Evidence is brought forward to support the theory that the endometrium elaborates a hormone which influences the ovary.

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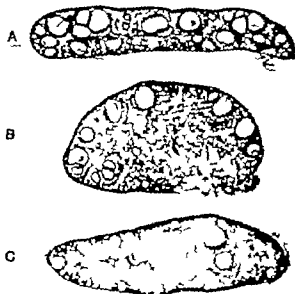


Fig. 1. Showing the relative number of secondary follicles (those with clear cytoplasmic formation) seen in A, the ovary of an adult rabbit in the resting stage; B, an ovary removed 6 months after a simultaneous hysterectomy and autotransplantation of endometrium and C, an ovary removed after a hysterectomy without transplantation of endometrium. Note that the ovary from the animal subjected to a hysterectomy and an autotransplantation of endometrium, B, possessed more secondary follicles than the ovary from the animal subjected to a hysterectomy without transplantation of endometrium, C, and that both of these ovaries possessed fewer secondary follicles than the control ovary A.

ever a careful search of all our material failed to disclose any remnant of a single corpus luteum.

The operation of hysterectomy appeared to have a definite influence upon the ability of the rabbit to exhibit heat. More than half of the hysterectomized animals at the time of operation were either pregnant (8) or exhibited moderate degrees of uterine turgescence (26). Following the period of wound healing the entire group was herded together yet in spite of this opportunity which was offered for the covering of one female by another no remnants of corpora lutea were observed in any ovary to indicate that a pseudo-pregnancy had occurred and therefore that estrus existed.

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THE RELATION OF PULMONARY TUBERCULOSIS TO ANORECTAL FISTULÆ

A CLINICAL, PATHOLOGICAL AND BACTERIOLOGICAL STUDY

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In clinical interpretation it is common experience that views change as more accurate and detailed scientific observations serve as a basis for a clearer insight into the actual conditions present. Medical history is replete with interpretations and discussions on anorectal fistulæ and the literature on this subject alone has assumed voluminous proportions. Several decades ago discussion centered about the question whether all anorectal fistulæ were of tuberculous origin or not, and proponents of either view were easily found. With the introduction of better scientific methods, agreement was more common and discussion was relegated mainly to an explanation of the origin of the condition which probably will never entirely be settled and which so far as practice is concerned is of little actual importance. In the discussions of anorectal fistulæ over the decades, there is to be noted also the influence of changed conceptions regarding tuberculosis in general and in this appears the controversy of aerogenic versus intestinal infection, and local versus hæmatogenous and lymphatic infection. Thus, historically Lockhart Mummery in 1929 advises us "The operation for fistula-ano is associated with the very earliest records of surgical literature. In the days of early civilization when cleanliness was a matter of secondary consideration—water being used chiefly for drinking purposes—and the horse was the only means of transport fistula must have been even a more serious inconvenience than it is now. In looking up the records of St. Mark's Hospital, he found that since the year 1909 the number of cases of fistula has steadily diminished. The number in 1926 being a little over one-half the number admitted in 1909—a fact which is easily understood in the light of increasing sanitary hygiene. Regarding the primary cause he cites abscess in the tissues surrounding the

rectum and classifies the causes as follows: (1) congenital cysts (2) foreign bodies (3) fissures or ulcers (4) suppuraton of the intramuscular glands, and (5) tubercle. Regarding the bacteriology he states "Apart from tubercle the nature of the infective organisms is probably not important. The pus from most fistulæ on culture shows a very mixed infection." Regarding the diagnosis of tuberculous fistulæ he states "Such fistulæ (tuberculous) can generally be diagnosed from the appearance of the parts but this is not entirely reliable. Examination of the pus or discharges for tubercle is quite useless. Histological examination of a few pieces of the wall of the fistula is fairly reliable but the only certain method is by inoculation into guinea pigs after concentration with anti-formin.

Reviewing the current German views on the etiology of rectal fistulæ, Thoms in 1920 cites Richard Volkmann and Franz Koenig as believing rectal fistulæ to be of tuberculous origin in the majority of cases while De Quervain considers at least half of them to be tuberculous, and Melchior in 1910 cites an incidence of 61 per cent, and Goetz reports 45 per cent in Munich. Opposing these views are those of Lanz who considers tuberculosis of little significance, those of Frey (1914) who found only 6.9 per cent to be tuberculous by macroscopic and microscopic examination of 72 patients operated upon. Frey insists that only the findings at the fistulous site are significant and the presence of tuberculosis elsewhere is not conclusive, while Melchior contends that even a negative microscopic examination cannot exclude the presence of tuberculosis in the fistulæ. The futility of arriving at conclusions from the methods used at that time is noted from this article.

In 1925 Fanaler read one of his first contributions on the relationship of tuberculous

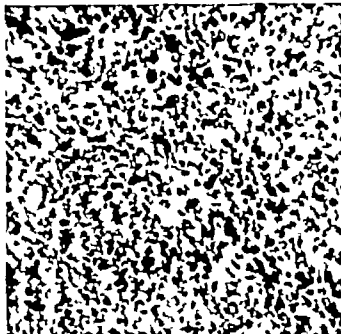
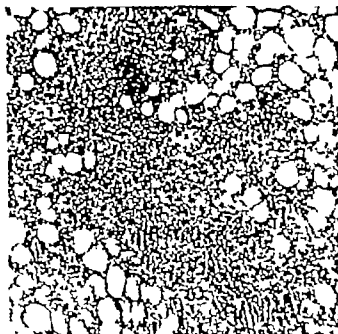


Fig. 1. Typical acute inflammatory (granulocytic) reaction in specimen from Case 137 found negative for tubercle bacilli by bacteriological examination. Left low power, right, high power



Fig. 2. Two examples of scar tissue (fibroblastic reaction) in bacteriologically negative cases for tubercle bacilli, left, Case 115, and right, Case 139.

to fistula in-ano before the American Medical Association. After reviewing the literature he asks six questions: (1) What constitutes a tuberculous fistula and on what findings are we justified in making the diagnosis? (2) What percentage of fistulae are tuberculous? (3) In what percentage of cases is the tubercu-

lous fistula the primary lesion and in how many cases is it merely a secondary infection from a focus elsewhere in the body? (4) What percentage of fistulae occurring in tuberculous patients are tuberculous? (5) Does pulmonary tuberculosis have a tendency to cause fistula in-ano? and, (6) Do simple fistulae



Fig 3. Two examples of mild chronic inflammatory tissue reaction. One from a specimen bacteriologically negative for tubercle bacilli left, Case 15 and the other bacteriologically positive for tubercle bacilli, right, Case 121.

occurring in non tuberculous persons indicate that the person has a tuberculous tendency. His answers, indecisively given are based partly on his personal experiences but mainly on conceptions formed from the studies of others. He sums up his beliefs as follows



Fig 4. A typical granulomatous tissue with monocytes and epithelioid cells in a specimen bacteriologically negative for tubercle bacilli, Case 102.

"(1) We are not justified in making the diagnosis of tuberculous fistula except by definite microscopic picture or in cases in which the lesion has the typical appearance (2) Considering all cases of fistula in ano it is doubtful whether more than 2 or 3 per cent are tuberculous in character (3) Tuberculosis is very rarely primary in fistula in-ano (4) Probably 15 per cent of fistulae occurring in tuberculous patients are tuberculous 0.33 per cent of tuberculous patients also have tuberculous fistulae (5) In view of the ease with which the tubercle bacillus affects the mucous membrane of the bowel it would seem possible that in some cases at least in some persons, in whom the fistula appear to be a simple inflammatory process, the original lesion in the bowel wall is due to the tubercle bacilli. However this is purely a matter of opinion and has not been proved (6) It is probable that tuberculosis as such has a tendency toward the formation of rectal fistula, and (7) it would seem that the formation of rectal fistulae in persons who are under weight is undoubtedly a warning of the presence of pulmonary tuberculosis or of a tendency toward its development

In 1930 and 1931 Petter and Fansler conclude from personal observations reported



Fig. 5. Giant cells in a specimen from Case 35 bacteriologically negative for tubercle bacilli. Left, low power right high power



from Glen Lake Sanatorium that tuberculous lesions about the anus and rectum occur secondary to a focus elsewhere in practically every case and that perirectal abscess and fistula in ano in the tuberculous patient present a typical history and clinical picture. They found perianal tuberculous skin lesions in 0.8 per cent of patients observed while perirectal abscess and fistula, in the same group, occurred in 5.8 per cent.

A study of 101 cases of abscess and fistula brought out several important facts, the 'proof of tuberculosis' is often quite a task. Smears of exudate are not reliable nor are guinea pigs inoculated with the exudate wholly dependable. A combination of three laboratory procedures gives a reliable 'proof of tuberculosis' (1) exudate in guinea pig (2) macerated tissue in guinea pig and (3) tissue section. Frequently tissue section will show a histological picture of chronic inflammation, but not tubercle formation and a piece of the same tissue injected into the guinea pig will show definite evidence of tuberculosis.

In 1926 Leslie following a careful study of the literature concludes that there is still no uniformity of opinion as to the etiological importance of the tubercle bacillus in ischio-

rectal abscess and fistula in ano and suggests that all abscesses and fistulae in large hospital services be submitted to the following tests (a) guinea pig inoculation of material from all specimens, (b) a histological study of sections from all cases, (c) a comparative study, following definite diagnosis, of the after history



Fig. 6. Giant cell in a specimen from Case 119 bacteriologically negative for tubercle bacilli.



Fig. 7. Giant cells in a specimen from Case 100 bacteriologically positive for tubercle bacilli.

of all cases treated and (d) more complete examination for tuberculous foci elsewhere.

The same year Clarke of Belfast reported his observations on patients with 109 cases of fistula having pulmonary tuberculosis at the Foster Green Hospital for Consumptives and Chest Diseases from which he drew the follow-

ing conclusions. Ischio-rectal abscess and fistula in-ano occur in males about eight times more commonly than in females—about 5 per cent of male cases of pulmonary tuberculosis are associated at some time with an ischio-rectal abscess or a chronic fistula. The fistula or abscess may precede the signs in the lungs by years. There is evidence that 61 per cent of cases of fistula subsequently develop pulmonary tuberculosis. There is evidence that fistula occurs 13 times more commonly in tuberculous males than in non-tuberculous males.

As a result of a study of 150 cases of fistula in-ano Tung reported in 1927 that the condition affects people of all classes in China, and that hemorrhoids and tuberculosis were especially noted in the histories. In 100 cases the specimens were examined microscopically and 26 or 25.5 per cent proved to be tuberculous.

Two important communications have been presented from St. Mark's Hospital which merit citation here. The one was an anatomical study in 1929 by Naunton Morgan who analyzed 100 cases of peri-ano-rectal infections and found that fistula is three times more common in men than in women. Of 106 new cases of fistula during 1928, 146 were men.

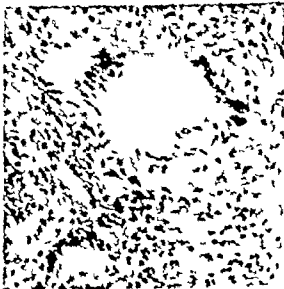


Fig. 8. Classical small tubercle and giant cells in a specimen from Case 52 bacteriologically positive for tubercle bacilli. Left, low power magnification; right, high power showing cells and two typical giant cells.

Anorectal infection was much more common after the age of 30 years, the age of greater frequency being from 30 to 40, the incidence gradually falling off until the age of 60. The condition is more common in children between the ages of 10 and 15 than between the age of 15 and 20. Most fistulæ pass radially into the bowel (46 per cent). Of these more than half are situated in front of a line drawn transversely through the anus (54 per cent). More than half of the ischiorectal abscesses communicate with the bowel and are—or will become—complete fistulæ (56 per cent). A tuberculous fistula will heal well and rapidly, if the patient's general condition is good and there are no signs of active pulmonary disease. Fistula appears to be complicated by pulmonary tuberculosis more frequently in patients over the age of 40 years. In over 60 per cent of the cases there was no definite cause found for the infection, foreign bodies were found in 4 per cent, hemorrhoids were present in 8 per cent, fissure was present in 7 per cent, inflammation of a crypt was present in 10 per cent. The initial lesion is probably microscopic and is overlooked.

The second and a most important study from St. Mark's which should be considered here, was reported in 1921 by Gabriel and has been frequently and repeatedly cited probably because it is the only detailed bacteriological and histological study of any extent performed to the present time in order to determine the percentage of rectal fistulæ that are tuberculous, the proof required being the definite demonstration or isolation of the tubercle bacillus. The cases investigated were not picked but were taken in succession as admitted into St. Mark's Hospital for operation. Cases of perianal abscess were included after discovering the futility of examining the discharge from tuberculous fistulæ in stained films, animal inoculation and histological methods were resorted to. In 30 of the 75 cases guinea pigs were inoculated. Pus scrapings, and granulation tissue were treated with an equal volume of 15 per cent antiformin after being ground with fine quartz sand and after being diluted with 10 to 20 cubic centimeters of normal saline solution the sand and larger particles of tissue being

allowed to settle, and finally the supernatant fluid being used for antiformin treatment. The antiformin is allowed to act for 5 minutes with constant shaking, the sediment then obtained by centrifuging is washed with saline and is then injected into the abdominal wall of a guinea pig. After inoculation the animal is kept alive for at least 6 weeks. The antiformin sediment is also examined in smear for bacilli.

Histological examination of the tissue was performed on all of the 75 cases examined, formalin fixation being used for this purpose, paraffin embedding and hæmatoxylin and eosin staining for cellular pathology and cold carbolfuchsin staining with methylene blue counterstaining for tubercle bacilli. Of the 30 cases studied by guinea pig inoculation 6 or 20 per cent, proved positive for tuberculosis, the ages ranging from 21 to 62 years. 5 specimens being from males and 4 of the 6 showed giant cells in sections while tubercle bacilli were found in none of the stained sections. The 24 negative cases were clinically simple with one exception, a man aged 35 years who had evidence of pulmonary tuberculosis involving both apices with tubercle bacilli in the sputum. Section from the granulation tissue of the fistula was negative also. Giant cells were found in sections in 2 of the 24 negative cases by inoculation.

In the 45 cases examined only by histological methods, tubercle bacilli were found in the stained sections of 4 (9 per cent) and all revealed characteristic giant cells. Two of these were from men (39 and 49 years of age) with no evident phthisis or pulmonary infection, while the 2 other men (both 18 years of age) had definite pulmonary tuberculosis. One case showed large numbers of giant cells (considered foreign body giant cells) but no bacilli, while of the 40 remaining cases 2 fistulæ were suspicious and showed giant cells but no bacilli. Thirty-eight proved clinically simple, and in 6 of these a few giant cells were found but were considered of no significance by Gabriel, thus leaving finally 32 of the 45 without significant findings for tuberculosis as usually considered. In concluding Gabriel brings out a few additional points not mentioned above but worth considering. If

histological examination only is carried out and if no tubercle bacilli are found in sections a consideration of giant cells can only give a presumptive diagnosis the absence of giant cells does not exclude the possibility of the tissue being tuberculous.

From a survey of the literature on anorectal fistulae it may be questioned whether practically the classification pathology or treatment of this condition bears any significance to the bacteriological phases of the condition as is evident from a recent article on this subject by Miles. But a better understanding of the bacteriology and pathology of the condition must inevitably influence the clinician and surgeon's viewpoint as well as that of all those concerned with the health of man and may eventually entirely change our method of approach in dealing with the condition of anorectal fistulae.

Since the investigations of the past decade have given us a better insight into the interpretation of tuberculosis and especially has resulted in crystallizing our conceptions regarding the quantitative relations between a positive finding for acid fast bacilli in a smear or section examined microscopically and a positive finding bacteriologically by culture or guinea pig inoculation for tubercle bacilli as contrasted to acid fast bacilli and since we are better able today to interpret the pathological findings from a practical standpoint as well as quantitative standpoint it appeared desirable to study more extensively and more accurately the relation of anorectal fistulae to pulmonary tuberculosis. In initiating this work there were recognized a number of inherent weaknesses in methods available for the so called diagnosis of tuberculosis.

Any method used has its limitations, and these must be fully recognized in interpreting the findings with a certain method. Thus, the finding of acid fast bacilli in a smear or section with the microscope indicates that there are present in the material about 100,000 bacilli per cubic centimeter while the guinea pig or culture are able to discern as few as 10 to 100 bacilli of a virulent strain of human or bovine tubercle bacilli. The guinea pig or culture when properly used discern only tubercle bacilli and eliminate the saprophytic acid fast

bacilli. A precaution in using guinea pigs is to exclude the possibility of spontaneous tuberculous infection which may lead to erroneous conclusions. The quantitative differences between the findings with the smear or section examined microscopically as compared to the guinea pig or culture are particularly significant when we consider that few bacilli can still produce disease and that the reaction may not be of a specific character. It must also be recognized that cellular reactions are significantly non-specific in character and that even the classical giant cell can be produced by a foreign body or by micro-organisms other than tubercle bacilli and finally tuberculosis can exist without characteristic giant cell formation or tissue reaction and that reactions to the tubercle bacillus are possible, running the entire range from an acute purulent reaction to the formation of dense scar tissue. Add to this the fact that sections, unless serial which is beyond practical consideration, can only picture the reaction of a very small portion of a diseased tissue and may range from normal tissue to a profound grade of pathology dependent almost entirely on chance.

However since only a limited series of cases was studied by Gabriel, and since the past 10 years have given us better methods of bacteriological diagnosis and most of all have given us a better conception of tuberculosis it was decided to examine pus, scrapings and tissues removed from fistulae in ano at operation using every precaution to avoid extraneous contamination and to utilize for examination histological and bacteriological methods and to obtain accurate clinical records regarding especially the status of the patient as concerned tuberculosis. The guinea pigs used in these tests were specially raised for this purpose with all precautions taken to avoid spontaneous tuberculous infection. The culture method used was that previously described from the Research Department of the National Jewish Hospital (3) the oxalic acid crystal violet potato cylinder method. Smears were stained by the usual Ziehl-Neelsen steaming carbolfuchsin methylene blue method while sections were fixed with Zenker's solution paraffin embedded and were

stained with either hamatoxylin and eosin for cellular study or with carbolfuchsin and methylene blue for acid fast bacilli. Since there is nothing unusual about the methods which have been used except what has been previously recorded for isolating tubercle bacilli the details will be omitted from this paper so that the pertinent clinical data and histological and bacteriological findings may be presented.

A total of 155 cases were studied in this series 106 being negative clinically and roentgenologically for evidence of tuberculosis, 18 presenting evidences of arrested pulmonary tuberculosis and 31 being active cases of pulmonary tuberculosis. None of the cases of pulmonary tuberculosis could be considered to be of the advanced hopeless or fatal miliary type at the time the specimen was obtained for examination. The term active is not intended to convey a last stage case in this sense but rather to indicate the usual clinical interpretations of activity including physical and roentgenological findings of activity, pyrexia, etc.

In order to evaluate the results of the histological findings they were graded according to the results of an examination of several sections usually taken at several layers in the block of tissue utilized for this purpose. A compromise had to be struck in the case of certain tissues and they are usually recorded according to the findings of more pronounced grade and pointing to the more marked changes toward a tuberculous tissue. Normal tissues were graded as being negative — "0" tissues presenting evidences of acute or sub-acute inflammatory reactions with a pre-dominance of polymorphonuclear leucocytes or granulocytes were graded as "? tissues presenting evidences of a chronic inflammatory reaction with scar tissue (connective tissue formation) as the more marked change were graded as \pm ", tissues presenting granulomatous changes with the various types of monocytes, clasmatoocytes or histiocytes with epithelioid cells and lymphocytes but no

TABLE I—BACTERIOLOGICAL AND HISTOLOGICAL FINDINGS IN THIRTY-ONE CASES OF ACTIVE PULMONARY TUBERCULOSIS WITH ISCHIORECTAL ABSCESES OR ANORECTAL FISTULÆ*

Case number	Age Sex	Bacteriological findings (culture and guinea pig)	Histological findings (sections or smears)	Remarks
7	21 M	+	2 pos	F A.
10	24 M	+	?	M. A. 2 yrs. anorectal pneumothorax
11	20 M	+	0	F A. 4 yrs. myocarditis
21	23 M	+	\pm	F A. 4 yrs. pneumothorax
23	20 M	+	2 pos	M. A. over 4 yrs.
4	42 M	—	\pm	F A. 7 yrs. hemoptysis
25	2 M	—	\pm	F A. 18 mos. hemoptysis
26	23 M	—	2 pos	F A. 0 yrs.
29	21 M	+	0	F A. 4 yrs.
30	16 M	+	2 pos	M. A. 3 yrs.
31	26 M	+	2 pos	F A. 6 yrs.
36	23 M	+	2 pos	F A. 5 yrs.
41	23 M	+	2 pos	F A. 6 yrs.
45	21 M	+	0	F A. 4 yrs.
54	23 M	—	0	M. A. 4 yrs.
57	6 M	+	\pm	F A. 18 mos. hemoptysis
60	22 F	+	+	M. A. 3 yrs.
73	21 M	+	2 pos	F A. 7 yrs.
77	22 M	+	\pm	F A. 4 yrs.
83	20 M	+	?	F A. 5 yrs.
85	22 M	—	0	F A. 6 yrs.
86	26 M	+	0	F A. 3 yrs. pneumothorax
88	22 M	+	0	M. A. 3 yrs.
89	22 F	+	0	F A. 6 yrs. chronic myocarditis
90	6 M	+	++	F A. 4 yrs. pneumothorax
95	21 M	+	?	M. A. 7 yrs. pneumothorax hemoptysis
99	22 M	+	\pm	F A. 6 yrs. pneumothorax
100	22 M	+	?	M. A. 3 yrs.
110	25 F	—	0	F A. 8 yrs. pharyngeal tonsy
121	42 F	—	\pm	M. A. 4 yrs.
127	2 F	+	\pm	M. A. 4 yrs. pneumothorax

0 means negative ? means acute cellular reaction \pm means scar tissue; + granulomatous tissue and ++ means tubercles or giant cells. In the majority of the cases the pulmonary tuberculosis was moderate (M. A.) or far advanced (F A.) Most of the patients had anorectal fistulae.

* Acid fast bacilli were not found in any of the sections stained with carbolfuchsin for this purpose in this series of cases.

TABLE II.—BACTERIOLOGICAL AND HISTOLOGICAL FINDINGS IN EIGHTEEN CASES OF ARRESTED OR INACTIVE PULMONARY TUBERCULOSIS WITH ISCHIORECTAL ABSCESSSES OR ANORECTAL FISTULÆ

Case number	Age Sex	Bacteriological findings (culture and guinea pig)	Histological findings (sections or smears)	Remarks
	22 M	—	—	Fibroid phlebitis 3 years
37	26 M	—	—	Fibroid phlebitis 6 years
44	43 M	+	++	Fibroid phlebitis 8 years
5	29 M	—	? pus	Fibroid phlebitis 8 years
44	41 M	—	?	Fibroid phlebitis 6 years
65	22 M	—	?	Fibroid phlebitis 3 years
7	21 M	+	++	Fibroid phlebitis 3 years
90	21 M	+	++	Fibroid phlebitis 3 years
98	20 F	+	?	Fibroid phlebitis 10 years
7	22 M	—	—	Fibroid phlebitis 7 years
	17 M	+	±	Fibroid phlebitis 8 years
24	20 F	—	?	Fibroid phlebitis 7 years
3	21 F	+	—	Fibroid phlebitis 6 years
27	21 M	+	+	Fibroid phlebitis 10 years
26	27 F	+	—	Fibroid phlebitis 8 years
24	21 M	—	—	Fibroid phlebitis 7 years
25	22 M	+	—	Fibroid phlebitis 7 years
146	21 M	+	—	Fibroid phlebitis 4 years

— means negative; ? means acute cellular reaction; + means acid fast; ++ means granulomatous reaction; and +++ means tubercle or giant cells.

Acid fast bacilli were not found in any of the sections stained with carbolfuchsin for this purpose in this series of cases.

typical giant cells were graded '+' while tissues containing typical tubercles and giant cells in any part of the section were graded '++'. It must always be remembered however in evaluating such tissue findings that tubercle bacilli can under certain conditions produce typical acute cellular reactions with a predominance of polymorphonuclear

leucocytes or granulocytes and that a typical solitary tubercle sectioned in different places can reveal a variegated picture. These facts combined with the additional fact that giant cells can form around foreign bodies including cellular debris make a diagnosis based on tissue findings alone of uncertain value. All the tissues from the 155 cases were examined for acid fast bacilli after staining with carbol fuchsin but in none were they found in spite of the fact that those presenting the classical tissue picture for tuberculosis were carefully examined although it must be admitted that none of these with giant cells presented profound tuberculous changes with numerous giant cells, such as were described by Gabriel. In the total of 49 cases with active and arrested pulmonary tuberculosis in this series, only 4 presented giant cells and in only 2 of these were they at all fairly numerous. In recording the bacteriological findings, the sum of the culture and guinea pig findings is recorded which in most instances were in accord.

The results of these studies are recorded in Table I for the active cases of pulmonary tuberculosis, in Table II for the arrested cases of pulmonary tuberculosis, and in Table III for the non-tuberculous cases.

An examination of the data recorded in Table I reveals that of the 31 ischio-rectal abscesses or anorectal fistulae occurring in cases of active pulmonary tuberculosis there were 24 specimens in which tubercle bacilli were found by guinea pig inoculation and culture methods while only one (Case 90) revealed tubercle formation or giant cells, another (Case 60) a granulomatous tissue reaction and in none was acid fast bacilli found in sections of the tissues removed or in smears from the pus obtained from the abscess or fistula.

An examination of the findings recorded in Table II indicates that among 18 inactive cases of pulmonary tuberculosis with ischio-rectal abscesses or anorectal fistulae, there were found 10 cases in which tubercle bacilli were present as determined by bacteriological means (guinea pig and culture test) while only 3 of the 18 (which were also included among the 10 positive by bacteriological methods) revealed tubercle formation or giant cells [in

sections and another one, also among the 10 positive bacteriologically, presented granular tissue changes but none was found to contain acid fast bacilli in sections or in smears from the pus obtained from the abscess or fistula.

Now if the bacteriological findings in the inactive arrested cases of pulmonary tuberculosis are compared with those for the active cases it is noted that 77 per cent of the active cases were found positive for tubercle bacilli by guinea pig and culture as compared to 55 per cent of the inactive arrested cases of pulmonary tuberculosis. Whether any great significance can be attached to the histological findings obtained in this study in view of all the facts in the case is to be doubted, yet it may be well to call attention to the fact that the giant cell is considered a pathological index of a mild or healing process as contrasted to a leucocytic or monocytic reaction which spells either a progressive or highly active process. The futility of placing too much reliance upon histological findings alone for diagnostic purposes is evident from our present knowledge of the cellular responses to tuberculosis as well as a recognition of the difficulty of examining more than a small portion of tissue by histological and microscopical methods.

The data tabulated in Table III appears to bear out the observations made on tuberculous individuals recorded in Tables I and II in that the histological tissue changes are unreliable as evidence for the presence of tuberculosis in anorectal fistulae, in 2 of 106 cases the findings were negative by bacteriological methods (with guinea pig and culture test) which revealed in sections typical giant cells, while in 15 of these 106 specimens evidence was presented of a cellular reaction (monocytic, histiocytic, and epithelioid cells) such as occurs in tuberculous conditions but which should not be considered specific for this condition alone. The striking result, however, to be noted from a careful examination of all this data is that tuberculosis of ischio-rectal abscesses and anorectal fistulae is practically limited to individuals with pulmonary tuberculosis evident by clinical and roentgenological examination. The incidence

TABLE III—HISTOLOGICAL FINDINGS IN ONE HUNDRED AND SIX PATIENTS WITH ISCHIO-RECTAL ABSCESES OR ANORECTAL FISTULÆ PROVIDED NEGATIVE BACTERIOLOGICAL DATA FOR TUBERCLE BACILLI AND PRESENTING NO CLINICAL OR ROENTGENOLOGICAL EVIDENCES OF PULMONARY TUBERCULOSIS

Age in years	Cases
20 to 30	36
30 to 40	20
40 to 50	26
Over 50	15
Total	106
Class 0	40
Class ?	24
Class ±	16
Class +	15
Class ++	2
Total	106

*The histological findings in these cases are recorded as in Tables I and II. 0 means tissues examined were normal, ? means tissues presented local areas of subacute inflammation with influx of predominance of granulocytes (polymorphonuclear leucocytes) ± means evidence of connective tissue (scar tissue) reaction, + means evidence of granulomatous infiltration including monocytes and epithelioid cells, ++ means the presence of typical tubercles with necrotic masses or giant cells.

appears to be slightly less in the favorable inactive or arrested types of pulmonary tuberculosis. It would appear also that the factors which are at play in permitting the invasion of the ordinary pyogenic organisms into the anorectal region and thus favor the production of abscesses or fistulae in this region also permit the entrance of the tubercle bacillus into these regions the original sources probably being the pulmonary focus with heavily laden bacillary discharge which on its course to being discharged from the body passes over certain predilection sites and favored by mechanical conditions, results in laryngeal, ileocecal and rectal localizations the sites of stasis and frequent mechanical tissue injury permitting entrance and then a suitable place for abscess formation with its ultimate rupture and fistula. Although the anorectal condition is dependent more or less upon the outcome of the pulmonary condition rectal hygiene can do much to prevent this condition and proper therapy based on the co-operation of the proctologist and the internist can do a great deal to remove it and prevent recurrences.

SUMMARY AND CONCLUSIONS

As a result of a review of the literature and a bacteriological and histological study of

tissue from ischio-rectal abscesses and anorectal fistulae in a series of 155 cases in which 106 patients were free from evidences of pulmonary tuberculosis, 18 had an inactive arrested fibroid phthisis and 31 had an active pulmonary tuberculosis, the following summarized conclusions are presented.

Tubercle bacilli are found by bacteriological methods (guinea pig inoculation and culture tests) in patients with ischio-rectal abscesses or anorectal fistulae only if pulmonary tuberculosis is present. Tubercle bacilli were found in 77 per cent of our patients with active and in 55 per cent with inactive (arrested or fibroid) pulmonary tuberculosis but they were not isolated in the 106 cases in which the patients were free from evidences of pulmonary tuberculosis. These findings suggest a close etiological relationship between tuberculous ischio-rectal abscess or anorectal fistulae and pulmonary tuberculosis. Histological methods were found unreliable for determining the tuberculous nature of anorectal conditions except possibly in the presence of marked involvement with typical tubercle formation and the presence of acid fast bacilli which was not a common finding in this series. The presence of giant cells or granulomatous tissue with monocytes and epithelioid cells proved not definitely pathognomonic of tuberculosis in the anorectal region. Acid fast bacilli are not commonly found in sections or smears from tuberculous ischio-rectal abscesses or anorectal fistulae with the aid of the microscope even though they

are readily found by reliable culture methods or guinea pig inoculation.

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EXCRETION OF BILE PIGMENTS IN EXPERIMENTAL OBSTRUCTIVE JAUNDICE¹

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THE question as to whether bile pigments are excreted into the intestinal tract in obstructive jaundice has received but little attention from investigators. Only two references to the subject were found in the literature. Wilbur and Addis while investigating the origin of urobilin, detected traces of this substance in the stools of dogs with common duct occlusion as well as in animals with complete biliary fistula. These workers concluded that urobilin was excreted into the gastro-intestinal tract as such from the blood stream. Wallace and Diamond, in the course of their liver function studies, found small quantities of urobilinogen in the stools of dogs with common duct occlusion and concluded that the urobilinogen originated from bilirubin eliminated into the gastro-intestinal tract from bilirubin saturated plasma.

Our attention was drawn to the subject by the finding of bile pigments in the aspirated stomach contents of a patient with longstanding obstructive jaundice. This was interpreted as indicating that the obstruction was not complete and that some communication had been established between the biliary system and the bowel. The question, however, was raised whether the obstruction might not, nevertheless, be complete and the bile staining of the stomach contents be explained on the basis of elimination into the bowel of bile pigments with the gastro-intestinal secretions.

Both Wilbur and Addis and Wallace and Diamond arrived at their conclusions concerning the excretion of bile pigments into the intestinal tract from a study of the stools alone. Apparently neither of these groups of investigators looked higher up in the intestinal tract for bile pigments. It seems logical to suppose that if in obstructive jaundice, bilirubin is eliminated into the intestinal tract, it should be possible by examining specimens of stomach and small bowel contents to detect this pigment before it has been transformed into urobilinogen and urobilin. The following ex-

perimental study was undertaken with this in view, namely to produce obstructive jaundice in animals and then (1) to study the bile pigment content at various levels in the gastro-intestinal tract and (2) to study the relationship of the elimination of these pigments (a) in the bowel and (b) in the urine, to the level of blood bilirubin concentration.

EXPERIMENTAL PROCEDURE

Dogs were used for all experiments. The animals were kept in metabolism cages and fed on a mixed diet. Operations were performed with aseptic technique, under ether anesthesia. After a preliminary period of 1 or 2 days during which the blood, urine and stools were examined for bile pigments, the common duct was ligated and resected about 1 inch from the duodenum in 16 animals. In 6 others a cholecystectomy was performed in addition to the common duct ligation. The stools were thereafter examined each day for bilirubin, urobilinogen, and hydrobilirubin. Blood bilirubin and urine bilirubin determinations were made daily.

During the earlier part of this work, 4 of the animals were explored after they had developed a pronounced generalized icterus. The biliary ducts were inspected to verify the absence of any communications with the bowel. Specimens of the contents of the bowel were removed through small incisions in the stomach, small bowel, and proximal colon and examined for bilirubin and urobilinogen. This practice was, however, discontinued because 3 of the animals expired during the operation and 1 several hours afterward. Since the operation occasioned little surgical trauma and very little loss of blood, we attributed the cause of death to the anesthetic. Ether had been used for 2 animals and nembutal, in minimal doses for surgical anesthesia (25 milligrams per kilogram body weight, given intravenously), proved equally fatal in the 2 others. The remaining

animals were explored only after death when specimens were taken from the stomach small bowel and colon. At necropsy each animal was examined to verify the completeness of the occlusion of the common duct and to ascertain the absence of anomalous communications between the biliary channels and the bowel. The method of obtaining specimens from the bowel was as follows: The bowel was incised and gross particles of food if present, were discarded. The material in the bowel was removed with a dull porcelain spoon care being taken not to scrape the mucosa. In some animals the bowel contained so little material that rather than risk scraping the mucosa, a segment of the bowel was rolled longitudinally and the contents gently expressed.

The chemical methods employed were

I. *Fæces* (1) Schmidt's test for hydrobilirubin. (2) Huppert's test for bilirubin (3) Urobilinogen was determined according to the method described by Wallace and Diamond

II. Gastro-intestinal contents in addition to those enumerated above the following test for bilirubin was also used

To about 10 grams of the fresh material to be examined 25 cubic centimeters of 0.1 per cent potassium hydrosulfide is added and the mixture vigorously shaken for several minutes, and centrifuged. To 2 cubic centimeters of the supernatant fluid, 2 cubic centimeters of the hydrochloric acid-sodium nitrate¹ reagent described below is added. In the presence of bilirubin the solution will turn green. This test is an adaptation of the quantitative urine bilirubin method described by Sabatini. We found this test much more sensitive than any of the other qualitative tests. Unlike the van den Bergh this test is specific for bilirubin since the development of the green color depends upon the oxidation of bilirubin to biliverdin.

III. Blood. Blood bilirubin was determined by the quantitative van den Bergh method. The standards described by van den Bergh are not of exactly the same shades as those

produced in the serum. Nichols and Jackson have described standards with more comparable colors. Comparison is made grossly against a series of standards in a comparator box. We have found this method adequate for the determination of variations of blood bilirubin concentration that exceed 1 milligram per 100 cubic centimeters. For the determination of changes of less than 1 milligram we have employed the microcolorimeter with the same standards of Nichols and Jackson.

Experimental results Excretion of bile pigments into the gastro-intestinal tract.

Fæces Tests for bilirubin were always negative in the stools of all animals. Tests for hydrobilirubin became totally negative in all cases after the second to the fourth day after operation, and remained so until death. Frequently no trace of hydrobilirubin could be detected during the preliminary period in normal dogs. We gained the impression that Schmidt's test for hydrobilirubin is of very little use in the detection of bile pigments in the stool though it is widely used by clinicians for this purpose.

The stools were always positive for urobilinogen in the preliminary period but in most experiments this substance began to disappear about 3 to 6 days after occlusion of the common duct. After the seventh post-operative day the stools remained constantly negative for urobilinogen until death in 16 of the 22 animals. Traces of urobilinogen were found constantly in the fæces of 3 (Nos. 13, 19, and 21) of the 6 remaining. In the 3 others (Nos. 7, 10 and 23) urobilinogen disappeared from the fæces for periods of 26, 23 and 24 days, respectively. The urobilinogen thereafter reappeared in these cases in the stools and persisted until death. The blood bilirubin in these at the time when urobilinogen began to appear in the stools was 54, 30 and 28 milligrams per 100 cubic centimeters, respectively.

Of the group that was constantly positive for urobilinogen, at autopsy one (No. 19) had a gastric ulcer another (No. 13) had diffuse ecchymotic areas in the mucosa of the large bowel, and the third (No. 21) exhibited nothing unusual apart from the marked generalized icterus and markedly engorged bile

¹Reagent. Concentrated hydrochloric acid, 15 cc. Water to 100 cc.

²Reagent. 1% sodium nitrite.

³T. 30 cc. of solution 1, 5-6 cc. of solution 2. This reagent must be prepared only as required, since it deteriorates after several hours.

TABLE I—EXCRETION OF BILE PIGMENTS INTO THE GASTRO-INTESTINAL TRACT IN EXPERIMENTAL OBSTRUCTIVE JAUNDICE

Animal number	Days after operation	Blood+ bili- rubin mg. per 100 c.c.m.	Stomach		Small intestines		Colon		Faeces			Remark
			Bili- rubin	Uro- bili- nogen	Bili- rubin	Uro- bili- nogen	Bili- rubin	Uro- bili- nogen	Bili- rubin	Uro- bili- nogen	Hydro- bili- rubin	
3	18	12	mg	o	•	o	o	o	o	o	o	Explored on 18th day ex- pired after operation
4	14	6	o	o	o	o	•	o	o	•	o	Explored on 14th day ex- pired after operation
6	9	23	•	•	•	o	o	o	•	o	o	Cholecystectomy
7	7	31	Trace	o	++	Trace	o	++	o	++	o	Necropsy Acetab. cirrhosis of liver. Stools positive for urobilinogen for 20 days before exitus
8	8	30	o	o	o	o	o	o	•	•	o	Cholecystectomy
9	2	14	o	o	o	o	o	o	o	o	o	
	43	30	o	o	+	o	o	+	o	+	o	Stools positive for urobili- nogen for 15 days before exitus
1	20	14	o	o	o	o	•	•	•	o	o	
3	35	26	o	o	+	o	o	+	o	+	o	Urobilinogen constantly per- sist in stools. At necropsy ecchymotic areas in mucosa of bowel
5	9	5				o	o	o	o	o	•	Explored on 11th day and expired on following day
17	18	13	o	o	o	o	o	o		o	•	
18	20	20	o	o	o	•	o	o	o	o	•	Cholecystectomy
19	30	3			+	o	o	+	o	+	o	Traces of urobilinogen in stools constantly present. At necropsy gastric ulcer
20	20	9	o	o	o	o	o	o		o	o	
	24	26	o	o	+	o	o	+	o	+	o	Cholecystectomy. Traces of urobilinogen constantly in stools
	26	24			+	o	o	Trace	o		o	
3	38	28	o	o	+			+	•	+	o	Stools positive for urobili- nogen for 9 days before exitus
24	24	5	o		•	o		o		o	o	
26	1	5	o	o	•		o		o			
28	o	14	o		o	o			o	o		Cholecystectomy
29	3	16	o	o	o		o		o		o	
30	18	28	o			o		o	o	o	o	Cholecystectomy

+These represent specimens drawn within 24 hr before exitus.

passages. The constant presence of urobilinogen in the stools of Nos. 19 and 13 is probably attributable to hæmorrhage into the bowel. With hæmorrhage bilirubin is introduced into the bowel which would account for the urobilinogen in the stools. No. 21 remains a puzzle. The possibility of bile entering the intestinal tract through some aberrant bile duct as well as the existence of some lesions in the gastro-intestinal tract which might ac-

count for hæmorrhage into the bowel were excluded at autopsy.

GASTRO-INTESTINAL SECRETIONS

The specimens removed from the group of 4 jaundiced animals that were explored under ether and nembutal anaesthesia were all negative for bilirubin and urobilinogen. The results of the remaining 18 that were examined after death are summarized in Table I.

Traces of bilirubin were found in the stomach of only 1 animal (dog 7) in the small bowel of 7 animals, and in the colon of none. Of the 7 that had traces of bilirubin in the small bowel the stools of 6 were positive for urobilinogen before death. Urobilinogen was found in the colon of all cases in the small bowel of which bilirubin had been found.

No urobilinogen was ever detected in the stomach and only once in the small bowel (No 7). Dog 7 presented two unusual features—presence of bilirubin in the stomach and of urobilinogen in the small bowel. This animal presented other interesting features that merit recording. The animal lived for 72 days with a complete obstruction of the common duct. At necropsy the peritoneal cavity contained 110 cubic centimeters of clear amber colored ascitic fluid. This fluid contained 40 milligrams of bilirubin per 100 cubic centimeters but no urobilinogen. The gall bladder was distended to about five times its normal size. The liver was cirrhotic.

DEDUCTIONS FROM EXPERIMENTS

On studying the experimental results summarized in Table I certain facts are noted:

1. If an animal survives long enough after a common duct occlusion bile pigments will appear in the gastro-intestinal tract. Bile pigments were found in the intestinal contents of all animals that lived more than 30 days after the experimental obstruction and none was found in the intestines of animals who survived for a shorter period.

2. Urobilinogen can be detected in the stools of animals with complete obstruction of the biliary ducts if the obstruction is of long duration. After death bilirubin was found in the small bowel of all these animals the stools of which had been positive for urobilinogen. In 1 animal (No 23) with stools negative for urobilinogen traces of bilirubin were found in the small bowel and of urobilinogen in the colon. Since it is a well established fact that urobilinogen is absorbed from the intestines, the absence of urobilinogen from the feces in this case is probably accounted for in this manner.

3. The blood bilirubin concentration must attain a certain level before bile pigments will

be excreted into the bowel. The blood bilirubin concentration exceeded 22 milligrams per 100 cubic centimeters in all animals that had bile pigments in their intestines. It seems however that the blood bilirubin concentration is not by itself the determining factor in the elimination of bilirubin into the bowel since in one animal (No 30) the blood bilirubin rose to 28 milligrams before death and no bilirubin or urobilinogen was found in its gastro-intestinal tract whereas, three other animals were eliminating bile pigments into the intestinal tract at lower blood bilirubin levels (No 13 at 26 milligrams, No 21 at 26 milligrams, No 22 at 24 milligrams). The degree of saturation of the tissues with bile pigments is probably the deciding factor in the elimination of these pigments into the intestinal tract.

4. Certain pigments are found only in certain portions of the bowel which are anatomically and physiologically distinct from each other. With but one exception in the entire series, bilirubin was found only in the small bowel and urobilinogen only in the colon.

The absence of bilirubin from the colon and urobilinogen from the small bowel is in agreement with the commonly accepted theory of urobilinogen formation. The bilirubin in the bowel is believed to be reduced by bacterial action to urobilinogen. While this process may take place to some extent in the lower part of the small bowel in only 1 case (No 7) was urobilinogen detected here.

URINE BILIRUBIN EXCRETION

The second part of this experimental work concerns itself with a quantitative study of the relationship of blood bilirubin concentration to bilirubin excretion in the urine. Since Mann and his co-workers (1) have shown that the bilirubin content of arterial blood is the same throughout the body while the bilirubin content of the blood of the accessible veins varies, all blood specimens were obtained from the femoral artery except where otherwise indicated.

Method. The colorimetric method of Saha (2) was used to determine the bilirubin concentration in the urine. The method consists

TABLE II—BLOOD BILIRUBIN CONCENTRATION AND URINE BILIRUBIN EXCRETION FOLLOWING COMMON DUCT LIGATION *

Date	Days after operation	Blood bilirubin mg. per 100 c.c.m.	Urine volume in cc. per 24 hr.	Urine bilirubin mg. per 100 c.c.m.	Urine bilirubin mg. per 24 hr.
11 16 10 1 17†	Preliminary period	0	70	0	
-18	1	1	220	Trace	Trace
9	3	1.5	250	5	9
20	5	2	300	4	12
11 2	4	2.5	85	5.5	16
11 2	5	5	330	6	9
1 3†	6	3	50	8	20
24†	7	3.0	160	11.5	24
5	8	4.0	130	9	20
11 26	9	4	31	1	21
1 27†	10	4.5	130	10	21
-28	1	4.5	240	10.5	26
20	5	5	23		40
1 30†	3	5.5	180	3.5	46
2-	14	6.5	960	13	54
2-	5	6.5	330	16	56
2-3	6		3	9	59
2-4	7	7	3.8	20	64
2-5	8	7.5	260	26	68
2-6	10	8.5	350	7	84
2-7	20	8.5	300	33	99
2-8	21	9	483		10
2-9		10	542	26	4
2-11	23	5	760	3	175
2-12	24	15	2000		20
2-11	25				

*Female dog, No. 24, weight 5 kilograms.
†Common duct ligated and severed. ‡Either splenectomy. Operation.
7-9 †Weight 5 kilograms. ‡Wound infection. †Wound infected. †Weight 9 kilograms. ‡Wt. 7 kilograms. ††Edema.

in the oxidation of bilirubin by a hydrochloric acid sodium nitrite mixture to biliverdin with the formation of a green color. This color is then compared in a colorimeter with an artificial standard (a mixture of chrome alum and potassium dichromate) representing a concentration of bilirubin of 1 to 1000. Although the author fails to mention it, the colorimetric standard can only be used with daylight since artificial light brings out a reddish phosphorescence in the standard. Specimens of urine should be examined

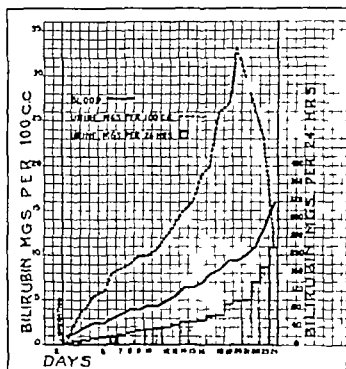


Fig. 1. Relationship of blood bilirubin concentration to urine bilirubin concentration and output in milligrams per hour following experimental obstructive jaundice.

while fresh, since a certain amount of bilirubin disappears from the urine on standing at room temperature. Specimens can however be kept in the refrigerator for 12 hours without the loss of appreciable amounts of bilirubin. Urines which have undergone ammoniacal decomposition yield colors which cannot be compared with the standard. Particular care should be taken to keep the urine clear of faeces. Particles of faeces soaking in the urine will interfere with the development of the characteristic green color.

In the experiments the specimens were collected immediately or shortly after voiding and filtered. The bilirubin determination on the specimen was then performed immediately. If the animal voided in the evening a few drops of toluene were added and the specimen placed in the refrigerator and examined in the morning. At the end of each 24 hour period the animals were catheterized.

The color of the urine after the addition of the reagent at times did not exactly match the shade of the standard. This was more noticeable in urines of low bilirubin concentration (3 to 5 milligrams per 100 cubic centimeters). Urines containing concentrations of bilirubin

TABLE III.—BLOOD BILIRUBIN CONCENTRATION AND URINE BILIRUBIN EXCRETION FOLLOWING COMMON DUCT LIGATION AND CHOLECYSTECTOMY *

Date	Days after operation	Blood bilirubin mg. per 100 c.c.	Urine volume cc. per 24 hr.	Urine bilirubin mg. per 100 c.c.	Urine bilirubin mg. per 24 hr.
2-2 to 12-31	Preliminary period		400		
2-3	5	50	50	50	50
2-5		50	5	37	8.25
2-6	3	30	400	65	265
2-7		8	15	54	90
2-8	5	8	264	71	180
	6	16	265	70	158
12-	7	18	50	80	300
2-	8	20	20	93	205
2-11	9	3	205		270
2-1					

*Female dog 6 weight kilograms. †Operation, 2-3-31. Common duct ligated and severed and cholecystectomy. Ether anesthesia. Weight kilograms. Abdominal wound infected. ‡Weight 7 kilograms. †Excess.

above 10 milligrams per 100 cubic centimeters always yielded shades comparable to if not identical with, the standard. While the method will not enable one to measure quantitatively the traces that occur in the urine below concentrations of 3 or 4 milligrams bilirubin per 100 cubic centimeters of urine, it is adequate for the quantitative measurement of the variations in bilirubin concentrations that occur in the urine following common duct occlusion.

Experimental results. The results of a typical experiment following common duct occlusion are given in Table II (Fig. 1). The gradual rise in blood bilirubin is paralleled by corresponding increases in the bilirubin excretion. Table III shows the more rapid rise of bilirubin in both blood and urine which occurs when a cholecystectomy is performed in addition to occlusion of the common duct. If the gall bladder is allowed to remain it seems to act as a reservoir for bile leading to a slow gradual rise in the blood bilirubin. In 2 of the 6 animals upon which cholecystectomies were performed, there occurred a rapid rise in blood bilirubin (Table III) followed by a falling of the blood values for several days, and in turn

TABLE IV.—BILIRUBINEMIA AND BILIRUBINURIA DURING FIRST SEVEN HOURS OF COMPLETE COMMON DUCT OBSTRUCTION *

Specimen	Time after operation	Blood bilirubin mg. per 100 c.c.		Urine bilirubin mg. per 100 c.c.	Urine volume c.c. per hr.	Urine bilirubin mg. per hr.
		Arterial	Venous			
1	Preliminary period	Negative	Negative			
2	30 min.	.25	.25	Trace	5	?
3	60		.25	1		.6
4	90			7.5		.8
5	20	5	5	10	1.5	1.8
6	30	5	5	20	1.5	1.8
7	30	3.5	3.75	14	20	.4
8	21	4.5	4.5	20	8	6
9	140	5.5	5.5	30	8	6.4
	170	6.0	6	47	6	3
1	200	6.5	6.75	8	25	2.8
	230	7	7.0	Trace	5.5	?
3	260	7.5	7.5	7.5	5	8
14	290	7.5	7.5	14.5		?
5	420	8	8.00	5	10	5
6	450	8	8.00	14	8	5

*Remarks. Female, weight 4 kilograms. †Catheter and catheter held in place with sutures. Right femoral artery and vein exposed.
‡Common duct ligated and severed under ether anesthesia.
§250 c.c. 20 per cent glucose intravenously.

by a steady rise until death. Urine bilirubin values paralleled the blood bilirubin fluctuations. The maximum value for blood bilirubin observed was 54 milligrams in dog 7 and occurred 72 days after common duct occlusion. The corresponding urine bilirubin concentration in the same animal was 270 milligrams per 100 cubic centimeters. This is a ratio of blood bilirubin to urine bilirubin concentration of 1.4. The highest ratio (1.8) occurred in dog 6. Blood bilirubin was 5 milligrams and the corresponding urine bilirubin 40 milligrams per 100 cubic centimeters. The curves of blood and urine bilirubin concentration did not always run parallel. The rate however of bilirubin excretion always paralleled closely the variations in the blood bilirubin concentration (Fig. 1).

In Table IV are given the results of an experiment in which arterial and venous blood and urine specimens were collected at half

hourly intervals. In order to ensure the simultaneous collection of arterial and venous specimens the femoral artery and vein were exposed. Mann and his co-workers (1, 2) using a spectrophotometric method for the determination of bilirubin reported higher blood bilirubin concentration in the femoral vein than in the blood drawn simultaneously from the femoral artery. We were never able to demonstrate differences of greater magnitude than 0.5 milligram between arterial and venous samples and these, not constantly. It is significant, however, that when differences were detected, the venous blood values were always higher than the arterial.

In 3 animals several days before death a drop in the blood bilirubin values and a corresponding fall in the bilirubin excretion occurred which continued until death (Table V). Postmortem examination of these animals revealed nothing to explain the terminal drop in blood and urine bilirubin. The common duct occlusion was complete in each case and no anomalous communications between the bile passages and the bowel were found.

CONCLUSIONS

1. In complete obstructive jaundice of long duration in dogs, bile pigments are eliminated into the gastro-intestinal tract and can be detected as bilirubin in the small bowel and urobilinogen in the large bowel. Urobilinogen can be found in the stools of the same animals although Schmidt's hydrobilirubin test which is widely used clinically for the detection of bile pigments in faeces was constantly negative.

2. The elimination of bile pigments into the bowel seems to be determined by a combination of factors. (A) The blood bilirubin concentration (23 milligrams per 100 cubic centimeters of blood was the lowest blood bilirubin level at which bile pigments were found in the intestinal tract). (B) The duration of the complete biliary obstruction. (Bile pigments were never detected in the intestinal tract of animals who lived for less than 30 days after the common duct occlusion.)

TABLE V.—TERMINAL FALL IN BLOOD BILIRUBIN CONCENTRATION AND URINE BILIRUBIN EXCRETION FOLLOWING COMMON DUCT LIGATION *

Date	Days after operation	Blood bilirubin	Urine volume per 24 hr.	Urine bilirubin mgm. per 100 c. cm.	Urine bilirubin mgm. per 24 hrs.
11-61 to 11-7	Preliminary period	0	200 c. cm.	0	0
11-8	1	3	170	5	8.5
11-9	2	3.5	220	8	15
11-11	3	3.5	30	0.5	2
11-11	4	4	10	1	1
11-13	5	5	2	1	27
11-14	6	5.5	100	4.5	28
11-15	7	6.5	204	14	20
11-16	8	7	175	7	30
11-17	9	7.5	132	2	20
11-18	10	7.5	205	10	33
11-19	11	6	153	21	35
11-20	12	5.0	170	13	26
11-21	13	3.5	155	13	19
11-22	14	3.0	100 c. cm.	9.5	

*Female, dog 4, weight 9 kilograms.

†1-7: other anastomosis. Common duct ligated and resected.

‡Examination, Necropsy: Complete occlusion of common duct, no anastomosis bile ducts. Generalized icterus. Gall bladder distended to about twice its normal size.

3. There is a close parallelism between the blood bilirubin concentration and the rate of bilirubin excretion by the kidneys following experimental obstructive jaundice.

The author wishes to express his thanks to Dr. Ralph B. Bettman whose interest made this work possible and to Dr. David J. Cohn for many helpful suggestions with the chemical methods.

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PYELOMETRY

A GRAPHIC STUDY OF THE CONTRACTIONS OF THE KIDNEY PELVIS¹

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In former communications the author has drawn attention to the study of the normal and pathological physiology and pharmacology of the kidney pelvis by means of pyeloscopy and of pyelometry in both the human being and in the experimental animal. In the present communication some results of the pyelometrical study of the kidney pelvis in the human being are submitted. The scope of the inquiry is, of course, limited by the material and facilities available in all cases the observations recorded by pyeloscopy, pyelography and pyelometry were studied in association with the clinical findings. Obviously in the human being the study of the action of drugs was limited by the pharmacological requirements of the case and the therapeutic indications as suggested by animal experiments (3).

With the conscious assistance of the patient the effects of various procedures could be investigated such as sitting up, lying down, lying on the affected side, lying on the opposite side, coughing, deep respirations, Valsalva's experiment (forcible expiratory effort with closed glottis at the end of inspiration) and alterations of posture by altering the inclination of the table on which the patient lay.

METHOD

A ureteric catheter as large as possible up to 7 or 8 Charnière was passed into the pelvis of the kidney. The position of the eye of the catheter was verified by examination under the fluorescent screen and the filling of the kidney pelvis with abrodil or uroselectan B solution was carried out under direct vision through the screen. The kidney pelvis being filled its contractions were observed and the passage of the globule down the ureter alongside the indwelling catheter observed. (This was obviously not a normal state of affairs but the findings could be verified by subsequent pyeloscopy after removal of the catheter.)

It is recognized that the presence of an abnormal fluid in the kidney pelvis is not a normal state of affairs and that the injection of this fluid into the pelvis through the indwelling ureteric catheter also introduces an unknown factor but, until pyeloscopy is possible with the dye in the pelvis excreted there by the kidney after oral administration or parenteral injection such as is done in intravenous pyelography the method must stand.

The kidney pelvis was then emptied of abrodil and washed out with normal saline and then connected up as illustrated in a previous paper (2 Fig. 1).

Drugs investigated were injected subcutaneously or intramuscularly. It is recognized that the intravenous route would be experimentally more desirable but this is not always clinically expedient. Again the drugs were used only in therapeutic doses and so the human being of 50 kilograms would receive intramuscularly or subcutaneously the same dose of such drugs as pituitrin, eserine, strychnine, atropine as the dog of 8 to 10 kilograms received intravenously and in the case of histamine and morphine a smaller dose. This may account for some of the differences noted.

RESULTS OBTAINED

In all tracings upward movement indicates contraction and downward movement relaxation. Time 90 mm = 1 minute. The normal tracing. The apparently normal tracing (Fig. 1) shows a series of small waves, generally 2, 3 or 4 in number superimposed on larger waves—generally on the ascending limb of the wave, but sometimes on the descending limb. I take these small waves to indicate contractions of the calyces while the large wave indicates contraction of the pelvis itself ("ventricle"). The rhythm is regular and the height of the contractions more or less constant.

1. *Effects of posture in the normal.* (a) Sitting up causes a marked and rapid rise in

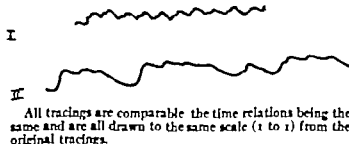
pressure up to a maximum when the tracing maintains a plateau. It sometimes however, gradually falls after reaching maximum level. In the latter case I take it that the urine under pressure in the pelvis is escaping *alongside* the catheter and so the pressure falls (Fig 2).

b On lying down after a momentary slight rise in pressure due perhaps to muscular effort the pressure falls rapidly to normal (Fig 2). The same effects were produced by raising the head of the table and then restoring the patient to the horizontal without any apparent conscious effort on the part of the patient.

2 *Increased intra-abdominal pressure* induced by muscular movement coughing laughing Valsalva's experiment all produce a rise in pressure in the kidney pelvis which is what one would expect (Fig 3). If the patient is made to sit up first and then told to strain cough or Valsalva there is a further rise superimposed on the first rise and this second is often as great as that induced by the same procedure with the patient lying down. With a small inlying catheter, if these procedures are repeated several times in quick succession the response becomes less. I think this is due to the emptying of the pelvis down the ureter alongside the catheter.

3 *Effect of drugs in the normal* Histamine in the doses given (grain 1/22 to grain 1/44) injected intramuscularly induces contraction of the kidney pelvis (Fig 4).

Atropine apparently causes contraction in the experimental animal (dog) (2) although in the human being relaxation is generally seen but sometimes a contraction is obtained (Fig



All tracings are comparable the time relations being the same and are all drawn to the same scale (1 to 1) from the original tracings.

Fig 1 Normal tracing I Mrs. B. Note calycinal contractions on upstroke i.e. during systole of the pelvic "ventricle." II Mrs. D. Note calycinal contractions on the downstroke i.e. during diastole of the pelvic ventricle. The difference in rate of ventricular contraction may have a bearing on this.

5) Apparently this effect is due to cutting out of vagal action (3).

Pituitrin generally produces a rise with 'flattening' of the wave and obliteration of the rhythmic contractions.

Eserine causes contraction although this is generally better seen pyeloscopically than graphically. It was also noticed that after eserine a much greater contraction was obtained when the patient sat up than was obtained before eserine was injected (Fig 6).

In pathological cases (a) In mild degrees of hydronephrosis (capacity of pelvis 15 to 20 cubic centimeters) the tracing obtained showed very shallow waves.

1 *Effects of sitting up* The rise induced by sitting up was very much less than in the normal. When however this procedure was repeated several times, a higher and higher response was obtained *with relief* of pain and the contractions of the calyx were better and larger. This confirms what one finds on pyeloscopy. This type of pelvis will be seen to contract well when nearly emptied and with

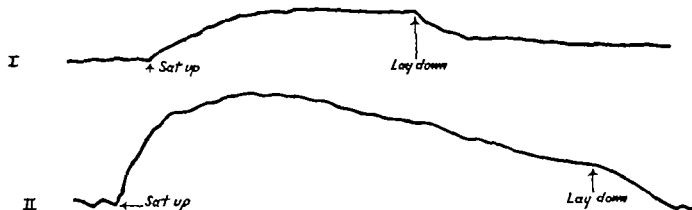


Fig 2 Effects of sitting up and lying down (see text) I Mrs. McL. same patient as in Figure 9 but normal (opposite) side. II Mrs. D. same patient as in Figure 1 tracing II

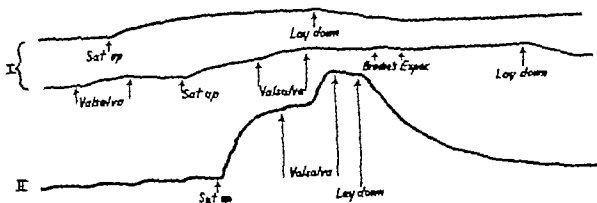


Fig. 5. Effects of sitting up, lying down, raising intra-abdominal pressure by Valsalva's experiment. I Mrs. I normal case. Small catheter. Cervical contractions not shown. II Mrs. W., slight dilatation of pelvis (capacity 5 cubic centimeters).

only 10 or 15 cubic centimeters abridgment solution run in. When however 25 or 30 cubic centimeters are run in the contractions are poor and the patient may complain of discomfort. Apparently the effect of sitting up and lying down several times in quick succession is practically to empty the overfilled pelvis with relief of pain.

2 *Effects of drugs.* Pituitrin appears to increase the tone in these cases without much increase in intrapelvic pressure as a result of the drug (Fig. 7). This is seen in the more marked response to sitting up than was seen before whereas in other cases a smaller response is obtained owing to the pelvis already being in a state of contraction.

In cases of dysfunction—irregular contractions associated with pain (Fig. 8) 1 *Effect of posture.* In some cases after the rise induced by sitting up the contractions become regular and pain is relieved (Fig. 8).

2 *Effects of drugs.* Pituitrin in these cases often does not produce so much a rise in intra-pelvic pressure as a steady of the pelvic contractions with production of regular waves (Fig. 8). In all cases of irregular contractions

with pain wherever the irregularities were corrected by posture or drugs the pain was relieved. With the return of the arrhythmia, the patient complained of pain once more.

RESULTS

The results so far obtained encourage one in the hope that the graphic method may give us information which can be studied at leisure and collated with pyelographic, pyeloscopic and clinical findings. The effects of posture are at first rather startling and will explain the beneficial results obtained by posture in some cases of pyelitis and in some cases of kidney pain. The apparent benefit derived from massage of the kidney region in some cases can also be understood when it is borne in mind that this massage may induce a rise in the intrapelvic pressure which would facilitate emptying of the pelvis and assist in overcoming slight spasm in ureter or pelvi-ureteral junction.

In regard to the action of drugs, as a rule the results obtained in the experimental animal (2) were confirmed but in some cases one obtained an apparent reversed action, but



Fig. 4. Action of histamine injected intramuscularly Mrs. B. Compare Figure 1 tracing 1.

whether this was due to the well known phenomenon of the reversed action of smaller dose or to the inherent difference in reaction of the human being and the dog to these particular drugs has not so far been fully investigated but such experimental observations as were made suggested the former

This was particularly the case with atropine and with histamine. Atropine in the doses given gave an apparent contraction of the pelvis in some cases but this contraction may have been secondary and due to cutting out of vagal action. In other cases relaxation of the pelvis with overfilling and consequent pain was obtained.

With regard to histamine a very definite rise in pressure was obtained in most cases with the doses given.

In neurotic women and women who were the subjects of spasm in the ureter or dysfunction of some kind as observed by pyeloscopy, it was seen that the normal contractions of the pelvis and calyces were much shallower than normal and sometimes hardly apparent. In these cases pituitrin, eserine and strychnine often failed to produce any further contraction so that the pelvis was apparently in a condition of hypertonic contraction. In these cases quinine grains, 5 given 3 times a day, generally caused relaxation (3) and relief of pain. The pyelo-ureterogram of such a patient is illustrated (Fig 9). After a course of quinine she is now apparently quite well and free from pain.

In other cases (Fig 8) also the tracing showed an irregular series of waves accompanied by pain and when the waves became regular the pain disappeared.

In studying these tracings one wonders whether the information obtained by the graphic method in other fields of investigation



Fig 5 Action of atropine

can assist us. The differences in amplitude of the waves obtained with the same size catheter and equal conditions in the recording apparatus in different patients suggest the possibility of these waves being some index of calyceal or pelvic output.

As S W Patterson and F H Starling (5) point out in regard to the heart the output is equal to and determined by the inflow and as long as arterial resistance is not raised the cardiac output may reach enormous proportions. If however the resistance to output is raised the venous pressure rises and the output may be appreciably affected. If the same set of conditions hold in regard to the kidney pelvis as in the heart, then we may establish the parallel in this wise. The outflow through the ureter corresponds to the outflow through the great arteries, the body of the pelvis corresponds to the ventricle, the calyces to the auricles and the urine flowing in to the calyces from the collecting tubes corresponds to the venous inflow via the great veins. Now if the parallel still holds then the output is equal to and is determined by the inflow and as long as there is no resistance to output the pelvis can cope (within wide limits) with whatever amounts of urine are poured in. If however the resistance to the output is raised then the pressure in the 'ventricle' and calyces must rise till it reaches the secretion pressure of the urine when the flow must cease. We thus see what far reaching effects may be produced on the kidney locally and

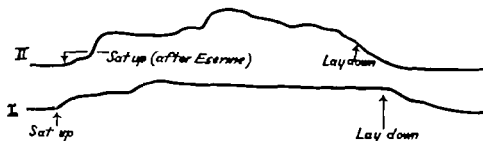


Fig 6 Action of eserine. Effects of sitting up and lying down before and after injection. I Before eserine. II After eserine.

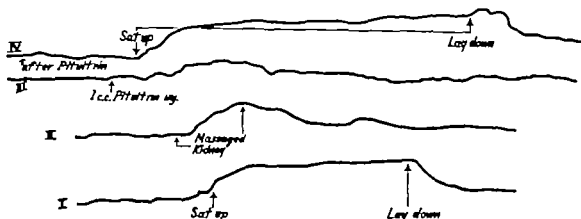


Fig. 7. Action of pituitrin. Note improvement in calycinal contractions in III after injecting pituitrin. II Improved response to sitting up after pit. itrin.

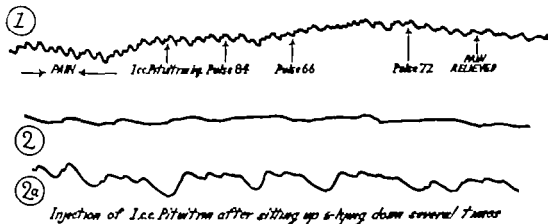


Fig. 8. Pelvic muscle dysfunction. Irregular contractions associated with pain. Pain relieved when contractions regular. In tracings 1 and 2 pain was associated with irregular contractions. Pain was relieved when contractions became regularized. 1 by injection of pituitrin (Mrs. B. Fig. 1). 2 by injection of pituitrin after sitting up and lying down several times (Mrs. D. Fig. 1).

the system generally by conditions of spasm or physical obstruction or kinking in the ureter. Recognizing how frequently one sees spasm of the ureter with or without antiperistalsis in the neurotic (especially when some condition in the urine such as crystals of phosphate, oxalates or uric acid act as exciting causes of ureteric spasm) one wonders how often the vague backaches and headaches in these people may really be attributable to some actual disorganization of kidney function on the lines outlined above.

We do know that in many of these patients the outflow of urine from the ureter to the bladder is not regularly and evenly distributed over a unit of time. The complete interpretation of the tracings obtained must how-

ever be deferred until a larger series has been obtained.

There is another point suggested by these tracings which is borne out by pyeloscopy. In observing a pelvis comfortably filled with a watery solution of abrodil 10 or even 20 contractions of the pelvis are often required to empty the pelvis. This suggests that the pelvis does not completely empty at each systole but retains a maintenance filling of urine and as this is added to by the systole of the calyces, the contraction wave in the ventricle forces this excess out. The height of the waves, therefore, may be an indication not of the "pulse pressure" in the pelvis but of the actual amount of fluid displaced from the pelvis at each systole.

We do know that in many cases of hydro-nephrosis the pelvis may hold quite an amount of urine which runs away in a steady stream when the ureteric catheter is passed into the pelvis whereas in some cases of spasm of the pelvis practically no urine drips from the catheter on passage the outflow being intermittent from the outset. If the maintenance filling varies in amount according to varying physiological conditions of circulation posture rate of secretion alterations in tone of the pelvis spasm or obstruction of the ureter by pressure from adjacent structures then it is easy to see how this variation may be reflected in alterations in amount or rate of kidney secretion while at the same time a variation in the direction of over filling or complete emptying may determine some of those obscure kidney pains which are so difficult to define and elucidate and which yet often reduce the patient to a condition of semi invalidism. A great deal more work is required on these lines before authoritative statements can be made on the subject but the results so far obtained by pyelometrical investigation of patients give one permanent records which can be compared with subsequent tracings and studied in connection with past or subsequent clinical findings. This preliminary investigation is also submitted in the hope that it may stimulate others with better facilities than the author possesses to carry out more extensive investigations on similar lines.

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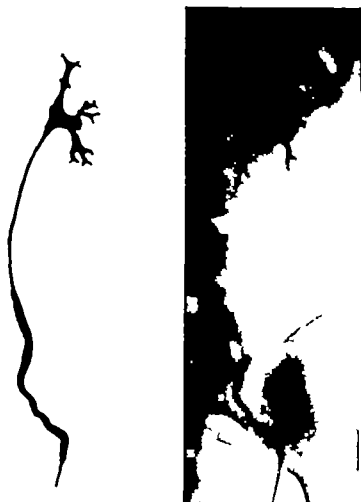


Fig. 9. Uretero-pyelogram. Mrs. McL. Spasm of kidney pelvis and upper part of ureter. The condition (and the pain) cleared up when quinine was given.

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Fig. 2. Case 1. Balloon cyst. Roentgenogram showing fluid and small amount of air in cyst. These findings led to the erroneous diagnosis of hydropneumothorax.

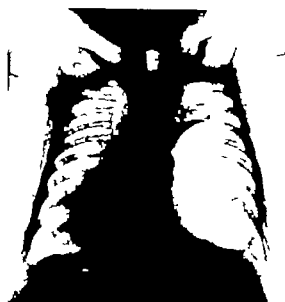


Fig. 3. Case 1. After spontaneous emptying of the fluid. Note the absence of collapsed lung at right hilum, but presence of normal lung markings at periphery which should help differentiate it from pneumothorax.

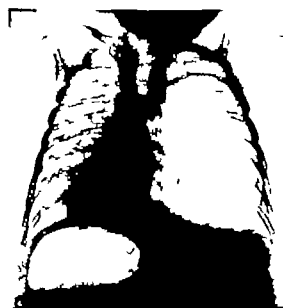


Fig. 5. Case 1. Roentgenogram made immediately after the withdrawal of 150 cubic centimeters of air. There is marked increase in the size of the cyst which is causing greater displacement of the surrounding structures.



Fig. 4. Case 1. Postmortem roentgenogram. Still greater displacement of neighboring structures. Note complete absence of lung markings on spine. There is marked decrease in density of the upper lobe, probably due to compensatory emphysema.

LARGE PULMONARY AIR CYSTS OF INFANCY

WITH SPECIAL REFERENCE TO PATHOGENESIS AND DIAGNOSIS¹

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APPROXIMATELY 150 cases of congenital lung cyst have been recorded in the American and European literature but only a few of these were in infants and in fewer still was the condition diagnosed and its course watched during life. In most instances the lesion was an accidental finding at necropsy.

In the 2 cases that we are about to report the diagnosis was made early and the patients were observed for a considerable time before death. The clinical and roentgen observations taken together with the necropsy findings suggest to us an explanation of the nature of air-containing lung cysts. This explanation is somewhat different from any of the many theories heretofore advanced as the result of necropsy study alone.

CASE 1. Balloon cyst. M. K., a white male premature infant had had a normal birth but was kept in an incubator for 10 days because of his small weight of 3 pounds 6 ounces. He was breast fed and seemed to develop normally until 7 weeks of age when his respirations gradually became difficult and rapid and a slight cough appeared. Physical examination by an attending pediatrician revealed a subnormal temperature and chest findings which were attributed to an atelectatic lung. There was no cyanosis or fever. The symptoms grew steadily worse and he was admitted to the Children's Memorial Hospital on September 3, 1931, 2 weeks after the onset of symptoms. At this time, 9 weeks of age, he weighed 6½ pounds. There was dullness and absence of breath sounds on the right side of the chest, and the point of maximum cardiac impulse was found slightly to the left of the mid sternum. Many râles were heard in the left lung. There were no evidences of congenital syphilis. The red count was 3,300,000, the hemoglobin 55 per cent and the white count 15,400 with a normal differential count. The diagnosis based on the physical findings was congenital atelectasis of the right lung in a premature infant. An X-ray examination on the following day (Fig. 1) showed a dense shadow obliterating completely the lower half of the right lung field. Above this lay a dome-shaped pocket of free air which had as its lower border a horizontal fluid level. Above this air pocket lay normal air containing lung tissue. These findings were interpreted as a right hydropneumothorax.

The infant took feedings well. There were frequent attacks of difficult breathing with cough and slight cyanosis. Between paroxysms he was not cyanotic but breathed rapidly. *He coughed up some viscous mucoid fluid on one occasion.* Another X-ray examination (Fig. 2) made 4 days later showed complete disappearance of the density from the right lung field in its place was a large air containing cavity. A thoracentesis had not been done. In successive roentgenograms this cavity gradually increased in size, pressing the mediastinal structures to the left and also the right leaf of the diaphragm downward. There was no evidence of a collapsed lung at the right of the spine. The apex of the right lung grew smaller and less dense as the amount of air increased in the cavity below. The diagnosis of pneumothorax was made although one attending physician (Dr. E. T. McNary) suggested the possibility of a lung cyst.

Labored respirations with cyanosis continued and when 10 weeks old a thoracentesis needle was

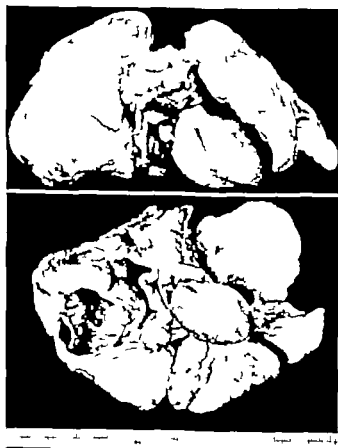


Fig. 5. Case 1. Anterior and diaphragmatic views of specimen (after fixation).



Fig. 6. Case 1. X-ray picture of specimen after cyst was filled with barium and gelatin.

inserted to reduce the pressure. About 150 cubic centimeters of air was withdrawn followed by relief of symptoms for but a few minutes. An X-ray (Fig. 3) taken 30 minutes later did not show the expected diminution, but instead an enlargement of the air containing space. Respiratory difficulty and cyanosis continued until death occurred 1 week later (age 11 weeks). Fever was not present at any time. Postmortem films (Fig. 4) showed the cavity to be larger and the mediastinal displacement even greater than in the films taken during life.

At necropsy the body was small, poorly nourished, but well developed. It measured 45 centimeters in length and weighed 5 $\frac{1}{2}$ pounds. The thorax was well formed and symmetrical. No



Fig. 7. Case 1. Injection of tracheobronchial tree showing bronchial distribution to region of cyst.

abnormalities were found except those within the chest. When an incision was made through the right costal cartilages, the sound of escaping air was heard.

A cyst like air containing chamber was found within the middle lobe of the right lung. It occupied practically the whole right side of the thorax and displaced the mediastinal structures to the left. The left lung was compressed and pushed behind the heart. The heart was normal. Laterally the cyst wall was loosely bound to the right costal pleura. It could be freed by blunt dissection, although the thin and delicate wall ruptured in a few places during this process. The other lobes were free from cysts, had a normal architecture, and were apparently not



Fig. 8a, left. Case 1. Photomicrograph showing mesothelium lined fluid cysts found near the large air cyst. $\times 115$.

Fig. 8b. Case 1. Photomicrograph of capsule of large air cyst, showing fibrous structure, absence of epithelial lining, and small bronchioles lying within wall. The adjacent alveoli are collapsed. $\times 35$.



Fig 9. Case 2 Stationary cyst. X ray appearance when child was 15 months old. Note comparatively thin wall next to heart and diaphragm. A lateral view showed a corresponding relationship to the posterior wall.

atelectatic. The upper and lower lobes adhered to the middle lobe so that the fissures were recognizable only as a fine line except on the posterior surface



Fig 11. Balloon cyst (Parnallee and Apfelbach). Note the cyst wall below and the absence of collapsed lung at the hilum.

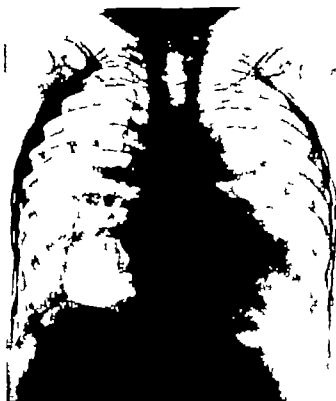


Fig 10. Case 2. Unchanged appearance 10 months later. Several roentgenograms which were made in the interim failed to show any relative change in the size of the air pocket.

of the lung where they were well marked. The lower lobe lay posteriorly extending to the left of the spine. The small upper lobe sat on the cyst like a



Fig 12. Pneumothorax. Note oval area of decreased density in right axillary region simulating a cyst. Later this area disappeared.



Fig. 13. Large cyst-like pneumothorax following pneumonia and emphysema. Although there are changes in the upper lobe and hilum shadows, knowledge of the clinical course is necessary to differentiate it from a large solitary cyst.

cocked hat. Atelectatic middle lobe parenchyma was present on the posterior aspect of the cyst, and also on the medial surface adjacent to the mediastinum.



Fig. 15. Massive positive pressure pneumothorax following emphysema. Arrow shows collapsed lobes which have retracted from the diaphragm. This point aids in the differentiation from lung cyst.



Fig. 14. Bullous emphysema secondary to congenital atelectasis. Appearance easily confused with multiple air cysts. A comparison with other films of this case ruled out cysts because of the lack of uniform arrangement of film densities at different examinations.

num. The cyst formed the lateral and anterior aspects of the middle lobe and its inferior surface rested on the diaphragm. Its wall was thin and was supported by contiguous parenchyma and the parietal pleura. The lining was smooth and white,



Fig. 16. Eventration or herniation of the diaphragm, resembling multiple lung cysts, may be diagnosed by the appearance of opaque shadows in this portion of the lung field following a barium meal.

and a fine deposit of white granular matter clung to the lower portion. At the hilum there were a few dimples and puckerings and when the lungs were insufflated under water a stream of bubbles came from this region.

The right main bronchus divided into two branches. The inferior branch extended into the lower lobe, the superior divided into a large trunk which ran to the upper lobe, and a short trunk which supplied the middle lobe (Fig. 3).

Microscopic examination. The alveoli of the middle lobe were partially collapsed, but otherwise normal. In two different regions, atelectasis was complete and here groups of microscopic cystic chambers ramified through the parenchyma among the alveoli. These cavities were of different sizes and outlines, some being circular others long tortuous and branching. Some chambers were dilated and filled with a clear albuminous coagulum their inner surfaces being outlined by flat cells of mesothelial character. The walls consisted of a thick layer of compact laminated fibrous tissue. Tiny fluid filled cysts, identical in structure, were situated in the wall of these larger ones (Fig. 8a). A few chambers were collapsed, with inflammatory mononuclear cells and multinucleated giant cells within their lumen and walls. These small cystic chambers microscopic in size were situated in the neighborhood of the large air containing cyst (which had a similar structure). The wall of the latter was made up of laminated cellular fibrous tissue containing numerous scattered smooth muscle cells (Fig. 8b). Occasional clumps of wandering inflammatory cells adhered to the inner surface. Its outer margin was somewhat indefinite and blended into the stroma of the surrounding atelectatic alveoli. In some sections, the wall of the cyst was thin consisting of only a single layer of connective tissue supported by collapsed alveoli nowhere however was the capsule completely absent. No elastic fibers could be stained within the walls of the cysts, or in any part of the lung tissue except the medial coat of the pulmonary arteries. No epithelial cells secretory glands, or prominent blood vessels could be found.

In the neighborhood of the middle lobe bronchus a small patent bronchiole (Fig. 7) lined with columnar epithelium lay within the cyst wall. It seems highly probable that this was the channel of communication between the cyst cavity and the bronchial tree, although no direct communication was found in a series of sections.

The following anatomical diagnosis was made: prematurity congenital lymphangiectatic cystic formation in right middle lobe of lung communication between a large chamber and a terminal bronchiole with the formation of an air containing thin walled cyst displacement of heart and mediastinum to left, compression of left lung malnutrition.

PATHOGENESIS

Congenital pulmonary cysts are found in individuals of all ages and in a variety of

forms. They are usually multiple and may be scattered, grouped, or confluent. Usually they are restricted to one lobe occasionally the distribution is through both lungs. They may contain mucoid fluid desquamated matter air, or pus. A small percentage appear to be lymphangiomatous formations. Other cysts which arise from the mediastinum are derived from ectopic islets of the primitive gut and possess a lining of esophageal or gastric mucosa. The large majority of the cysts however possess a lining of cuboidal epithelium supported by fibrous tissue, smooth muscle, and cartilage, and seem to be bronchiogenic in character. For the pathogenesis of this last group a variety of theories has been proposed, including congenital bronchiectasis (11), excessive growth of interstitial fibrous tissue (1, 32) defective energy of growth (18), underdevelopment of alveoli counterbalanced by widening of the bronchi (6, 24) and congenital atelectasis (10, 12). Congenital syphilis (28) fetal pleural adhesions (25) neoplastic processes (20), and bronchopneumonia (4) have also been suggested. All such speculations as to origin have been based almost entirely on the morphological evidence of necropsy findings. In most instances, postnatal changes caused by respiratory action rupture of the cyst or the presence of infection have confused and distorted the primary pathological picture. The reader is referred to a summary of 108 cases by Koontz (17) 1925 and to a more recent critical discussion of the theories of origin by Mueller (23), 1928.

There can be little doubt that the cysts found early in infancy are true congenital malformations arising from several different sources in embryonic life. However, once a large cystic cavity has been formed, its behavior should be determined largely by mechanical and accidental influences, such as capsular strength, proximity of adjacent air passages, plasticity of the surrounding lung tissue and the presence or absence of complicating respiratory infections, rather than by its embryogenesis or histology of its lining.

The consensus of investigators has been that large air cavities are preformed but col-

lapse at birth and distend at the first inspiration or else that they develop from small congenital bronchiectatic dilatations, which enlarge in postnatal life as the result of stenosis of their orifices. However a third possibility suggests itself the large air cyst may have been primarily a large fluid filled sac which evacuated itself spontaneously by rupture into a bronchus and became filled with air.

Just such an origin was manifested by our air containing cyst (Case 1) which originally had been a large fluid filled chamber within a congenital cystic malformation of the lung. While under observation its fluid content disappeared, presumably following rupture into a bronchiole. A small quantity of mucoid material was coughed up and the remainder was apparently swallowed. The emptying cavity instead of collapsing filled with air it then proceeded to dilate and balloon out as the result of valve like behavior of its bronchiolar opening and eventually produced respiratory difficulty and death. These changes were followed roentgenologically and verified at necropsy. So far as we have been able to determine this is the only instance where such a series of events has been followed clinically.

On histological examination the cystic formation appeared as a lymphangioma ramifying through the alveolar septa. Although the large majority of lung cysts reported have resembled epithelium lined bronchioles in Virchow's case and in those of Meyer and Kessler as restudied by Klebs, similar mesothelium-lined cysts, considered lymphangiectatic were scattered through the interstitial pulmonary framework.

Lung cysts are so rarely diagnosed during life that not much is known about their clinical behavior. When a large cyst is found in an adult one cannot say whether it had been present in essentially the same form since infancy or had recently developed or had changed its form and size within the past few years. The number of cases reported with satisfactory clinical studies is very small. The recent articles of Miller and Eloesser are doing much to arouse interest in the subject in this country.

We have found reports of 5 lung cysts which, at the time of discovery were large and air containing and which in their clinical behavior were identical with our case in its later stages. These occurred in infants in whom symptoms of respiratory distress had begun some weeks after birth. All showed extreme distention or steady increase in size. The cysts that were aspirated promptly re-filled with air. Those examined at necropsy were found to possess a narrow communication with some bronchiole which usually entered by a tortuous or oblique route. None of the patients survived 18 months of age. A brief review of each case follows.

An infant girl, having a large solitary air containing, expansile cyst was reported by Parmelee and Apfelbach. She had been seen at The Children's Memorial Hospital when 11 weeks of age because of frequent attacks of dyspnea and cyanosis, and presented clinically the signs of pneumothorax. Aspiration of air was followed by collapse necessitating the use of artificial respiration to maintain life. From that time on, the child went along with moderate symptoms of respiratory distress, until she succumbed to a complicating bronchopneumonia at 17 months of age. Necropsy revealed an enormous epithelium-lined cyst with a bronchiole entering it by a devious course through a network of identical microscopic chambers lying within the wall of the main cyst. The lung covered only one-half of the cyst surface.

Altmann observed a structurally similar formation in the lung of a female infant who died at the age of 2½ months with a diagnosis of percutaneous bronchopneumonia. The right lower lobe contained a gas filled cyst, which, after fixation, measured 7 by 5.5 by 4.5 centimeters. Half of its upper surface lay immediately below the parietal pleura the remainder was in intimate association with the lung parenchyma. It had a thin wall with a smooth glistening inner aspect, and two semi-circular partitions on the posterior surface. A bronchiole the size of a small bristle communicated with the cyst.

Miller in 1926 described a large air containing cyst, as demonstrated by roentgenological and clinical signs, in a child 5 weeks old. There were severe attacks of dyspnea lasting from 15 to 30 minutes. At first the condition was thought to be a pneumothorax on the right side, displacing the mediastinum and heart to the left. Repeated thoracenteses released air under pressure, and gave temporary relief from the respiratory embarrassment. Later, a small rubber tube fitted with a one way valve which allowed the escape but prevented the aspiration of air was inserted into the cavity. Marked improvement occurred. After the air containing pocket had decreased greatly in size, the

tube was removed 2 weeks later the cyst was found to have regained its original volume. The child died at the age of 5 months apparently from asphyxia. No necropsy was performed.

Burghard (1926) described a large air distended cystic cavity in the left lung of a 2 months old infant who died of a terminal bronchopneumonia. Dyspnea had been present since 2 weeks of age. The cyst was found within the parenchyma of the lung which itself was emphysematous. The opposite lung was a little compressed and the mediastinum displaced to the right. The cavity communicated with the bronchial tree through a tiny bronchiole. Its wall was thin the microscopic structure was not reported.

Huenermann and Sievers (1930) describe a multiloculated cystic formation or "honeycomb lung" which filled the left chest of a 2 weeks old infant, causing dextroversion cordis and compression of the right lung. This was air containing when the infant was first seen. It rapidly increased in size and produced symptoms of cyanosis and dyspnea. Thoracocentesis removed air under pressure but gave no relief of symptoms. Death occurred at 3 weeks of age. The postmortem X ray film showed a left pneumothorax with the cystic left lung partially collapsed and clearly outlined. Necropsy demonstrated multiple distended air containing chambers within the left upper lobe. Several entering bronchioles were present.

A suggestion as to pathogenesis is ventured in the first three of the above reports and each author assumes that the large cystic chamber began as a small air containing bronchiectasis which dilated in postfetal life. Inasmuch as in all but one a large portion of the wall was situated subpleurally it would follow that in expanding the cyst must have torn its way peripherally through enveloping lung parenchyma within the short space of a few weeks. One would expect to find therefore as a consequence of the quick gigantic increase in size a greatly stretched thin walled capsule and a flattened lining with some areas of rupture. Instead however these cysts characteristically had the opposite structure with well developed columnar epithelial lining and thick fibromuscular capsules.

In our own case with a wall thinned in places this change was due to secondary ballooning with air after the fluid contents had been discharged.

Because of the similarity in gross appearance, age incidence and clinical behavior of the above air cysts to the later stages in our case it seems probable that they all had a

similar beginning i.e. from the rupture of a fluid containing cyst. Their well developed walls are consistent with this interpretation as is also the presence in each of an entering bronchiole. Rupture and evacuation must then have occurred soon after birth.

Swanson, Platou and Sadler in 1928 reported a solitary fluid containing cyst noted in an infant 7 weeks of age. There were frequent attacks of cyanosis and dyspnea and the right side of the chest showed impaired resonance and suppression of breath sounds. X ray examinations revealed a dense opaque area throughout the whole right side of the thorax with some areas of decreased density near the base. The heart and mediastinum were displaced to the left. After it was tapped the cyst refilled rapidly with prompt recurrence of symptoms. An open fistula was made surgically when the child was 3 months old and the cavity was irrigated repeatedly. In 2 months it decreased in volume from approximately 200 cubic centimeters to 8 cubic centimeters as measured by sodium iodide injections. There was no evidence of an open communication with a bronchus. The child died following a bronchoscopic examination. Cells of glandular tissue were found in the wall of the contracted cyst at necropsy.

This large fluid cyst occurred in an infant whose age was comparable with that of the cases of air cysts discussed. If rupture into a bronchus had occurred we believe it would have shown the X ray appearance and expansile behavior of the air cysts already described. Its clinical manifestations resembled closely that of our own case when first observed.

Several reports have been made of cysts structurally like those in the case of Huenermann and Sievers but containing fluid instead of air. These were found in stillborn fetuses or in infants living only a few hours. Wolman described a dilated fluid filled bronchiogenic cystic structure in the lungs of a 6 months stillborn fetus. Pappenheimer reported an identical cyst in an 8 months premature infant who lived only 3 hours. No communication with the bronchial tree could be demonstrated in either case. In Kessler's 6 months old fetus, cystic fluid filled lymphangectatic chambers ramified through the pulmonary framework. Grawitz also described a fluid filled cyst in the lung of a newborn. Obviously postnatal factors can be ruled out in these instances. It seems likely that many of the

cases reported as congenital bronchiectasis originated as similar cysts in fetal life.

It is necessary that all air containing cysts possess an outlet into the bronchial tree patent at intervals if not continually since otherwise the contained air would be absorbed in the course of time. In the group of large air cysts described all maintained their large volume and some increased in size, which indicated that air entered more rapidly than it was absorbed. It seems probable that the communicating bronchiole entering the cyst cavity by an angular tortuous course acted as a valve allowing entrance but preventing outflow of air. At each expiration air pressure within the cyst became raised temporarily above the external intrathoracic pressure with a resultant expansion and gradual stretching of the wall until the maximum size permitted by structural conditions of the lung and mediastinum was attained. As the cyst expanded labored breathing and cyanosis resulted just as would occur in massive pneumothorax and death ensued from asphyxia unless the process ceased spontaneously or was interrupted by surgical interference.

It is easy to understand why these expanding cysts are not encountered in older children and in adults. In premature and young infants, all tissues (37) including the pulmonary parenchyma are relatively weak, friable and poorly resistant to the strains of tension and other trauma. In our first patient a premature infant who was 11 weeks old at death the pulmonary elastic fibers which normally appear in the first or second month postpartum (19) had not yet developed.

If there is no valve action at the communicating bronchiole or if the location of the cyst is such that neighboring structures support it, or if a chronic infection has provided support by causing a deposition of fibrous tissue, the cyst may remain constant in size. The following case seems to support this view.

CASE 2: Non-expandible cyst. A premature female child was observed for 10 months at The Children's Memorial Hospital, during which period she had frequent bouts of fever, with cough and dyspnea, sufficient to require admittance to the wards on

four occasions. She was constantly undernourished, her greatest weight being 12 pounds 8 ounces. No physical signs of a cavity within the lung were elicited the most constant chest findings were impaired resonance and higher pitched breathing in the right lower lobe behind. Frequent roentgenological examinations during each period of hospital care showed a constant oval area of decreased density in the right lung at the cardiophrenic angle. The lateral border of the cavity was dense and the hilum markings above it were prominent presumably because of superimposed infection. Death from bronchopneumonia occurred at 15 months of age. Necropsy permission was not obtained. The diagnosis was chronic bronchitis and bronchopneumonia, congenital cyst of lung, congenital heart defect, bilateral cataract, malnutrition. We believe that the diagnosis of a congenital cyst, rather than a localized pneumothorax is favored by the contour of the air pocket, its location and failure to absorb and the associated presence of other anomalies. Steinmeyer (31) and Eloesser (9) have described somewhat similar cases.

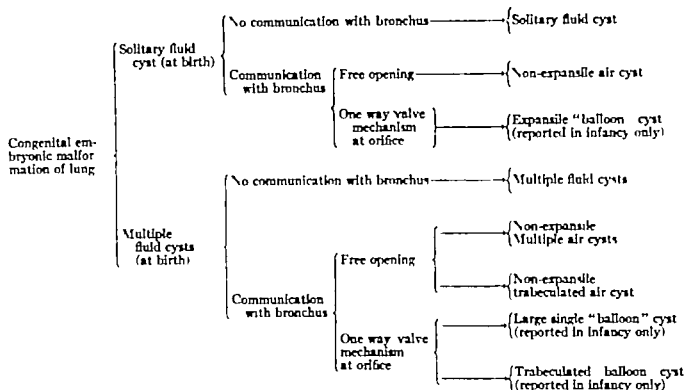
Based upon the above observations and discussion we venture the classification of lung cysts as shown in Table I.

DIAGNOSIS

Large cysts occurring in the lungs of infants produce first an increase in the respiratory rate and later cyanosis. If the cysts contain fluid there may be local dullness and absence of breath sounds, but if they are filled with air there is hyperresonance and the breath sounds are faint or high pitched. If marked displacement of the heart and mediastinum occurs, percussion dullness may appear over the normal lung as it becomes compressed. Large cysts may produce dyspnea difficulty in swallowing or cough and in extreme cases the chest may bulge. Small cysts may produce no symptoms at all or only those due to superimposed infection.

There appear to be no pathognomonic roentgenological characteristics of a fluid containing cyst but a large dense shadow surrounded by normal appearing lung tissue, in an otherwise quite healthy infant, should arouse suspicion of that condition. Contralateral displacement of the mediastinum is usually not, by itself a dependable sign. In infants an erroneous diagnosis of atelectasis is most likely to be made as occurred in the early stages of our Case 1. Aspiration of viscous fluid may be necessary to differentiate between

TABLE I—SUGGESTED CLASSIFICATION OF CONGENITAL LUNG CYSTS ON THE BASIS OF POSTNATAL BEHAVIOR



a fluid filled cyst and encapsulated fluid from other causes

Upon the roentgenological findings chiefly does the differentiation between positive pressure pneumothorax and balloon air cyst depend. In the latter the air containing cavity lies *within the lung* and enlarges as the gradual addition of trapped air by exerting a uniform outward pressure stretches the cyst wall and displaces the surrounding lung tissue around it in all directions. Consequently the lung tissue can be recognized upon the film as normal or varied densities at the apex, the costophrenic, and the cardiohepatic angles. The shadows of hilum structures on the mesial side of the lung field soon fade partly because of their migration about the surface of the cyst, but principally because of the early displacement of the easily movable mediastinal boundary of the lung contralaterally. In massive pneumothorax on the other hand the air lies in the pleural cavity separating the normal contact of the visceral and parietal pleurae and exerting pressure from *without the lung* upon its entire pleural surface. This pressure produces collapse of the whole lung with displacement of the mediastinal struc-

tures to the opposite side. The lung parenchyma at the hilum is not thinned out nor are there the shadows of tissue at the apex and angles. A readily noticeable differentiating point is the retracted collapsed lower lobe in massive pneumothorax (Fig. 15). Visualization of a dense curved line which assists in making a diagnosis of a cyst in the presence of other evidence must not be depended upon as a pathognomonic sign when occurring by itself, since adhesive bands as in pneumothorax following empyema may produce a somewhat similar appearance. A trabeculated cystic cavity may show as a network of thin densities on the film and may be confused with multiple bands of pleural adhesions. Here the history of a previous pneumonia or empyema supports the diagnosis of pneumothorax. It is significant that our Case 1 was called pneumothorax by all the members of the staff except one, who was familiar with the roentgenograms of a previous case of balloon cyst and noted the resemblance.

Massive pneumothorax, complicating a solitary cyst, aids rather than confuses the diagnosis if the pleural air happens to be

distributed so as to outline the contour of the collapsed cystic lobe. This point is beautifully demonstrated in the illustrations accompanying the report of Huernemann and Sievera.

Smaller air cysts are recognizable as rounded areas of decreased density with a smooth linear outline. When conditions permit radio-opaque oil dropped into the bronchus may fill the cavity or may make its contour more clearly evident by filling the adjacent bronchial tree. The differentiation between a small air cyst and a localized pneumothorax (Figs. 12 and 13) may be difficult or even impossible at a single roentgen examination. Repeated observations, however, will usually show fixity in the case of a cyst and definite liability in a pneumothorax.

Bullous emphysema (Fig. 14) often appears as multiple air containing areas of decreased density upon the X ray film. In infants these are frequently secondary to irregular areas of atelectasis which show as increased densities. Successive examinations will usually demonstrate that the air containing spaces and the dense atelectatic portions fluctuate somewhat in density and relative size. There is also of course absence of a dense linear cyst wall.

True diaphragmatic hernia or eventration of the diaphragm (Fig. 16) with gas or fluid in the thoracic portion of the intestine or stomach can simulate roentgenologically as well as clinically solitary or multiple air or fluid containing cysts. Fluoroscopic examination, following the administration of oral barium, will demonstrate the misplaced stomach in the thorax and subsequent X ray films will outline the cyst-like loops of the herniated intestine.

Duken and Vollmer have each described a case of pneumatocele following pneumonia, in which a large air containing oval was found in the lung. Since these completely disappeared following a single aspiration we believe that a localized pneumothorax could better explain the findings. In our experience and that of Bigler (2) subpleural blebs do not attain a large size, and we have never been able to demonstrate them on the postmortem X ray films taken before the necropsy which reveals their presence.

Stein's (20) case reported as congenital pneumothorax was 1 week old when first observed and is 2½ years old now (30). The published films demonstrate a sharply outlined air pocket with pneumatic lung at the costophrenic angle a condition that is characteristic of large solitary cysts. We have, moreover, been unable to find a report of any case of congenital pneumothorax proved by necropsy.

A cyst filled with fluid usually presents a poorly defined margin, scarcely to be confused with the sharp borders of chondroma (13) ganglioneuroma (3) or echinococcus cyst.

TREATMENT

A thoracentesis was done in 4 cases of balloon cyst that were studied during life. Two were temporarily relieved (our Case 1 and Miller's patient). Another (Parmelee and Apfelbach's) collapsed during the procedure and was revived by artificial respiration; the fourth (Huernemann and Siever's) developed a pneumothorax which hastened the exitus. A drainage tube with a valve allowing only the outlet of air gave effective relief for a few days to Miller's patient. A large fluid cyst in a small child (Swanson, Platou, and Sadler) was drained and became greatly reduced in size. While surgical removal of lung cysts has been successfully accomplished in adults, it has not been attempted in infants. It is hoped that through a greater knowledge of the pathogenesis and behavior of congenital lung cysts, recognition during life will occur more often and that a satisfactory treatment will eventually be devised to prevent the present high mortality in infants and young children.

SUMMARY

Two cases of lung cyst observed in infants are described. One of the cysts originated as a large lymphangiectatic fluid filled chamber which evacuated spontaneously and then ballooned out with air producing a fatal outcome. The other which was not verified by necropsy showed a constant X ray appearance over a long period.

Fluid cysts in infants, which are usually mistaken for atelectasis, do not have a char-

acteristic roentgenological appearance, but air containing lung tissue about an area of increased density should arouse suspicion of the presence of a cyst

The diagnosis of balloon cysts depends upon successive x ray and clinical studies and upon an understanding of the late stages of pathogenesis Usually an erroneous diagnosis of pneumothorax has been made The main roentgenological diagnostic points of a balloon cyst are the presence of lung tissue at the apex and angles and its absence at the usual hilum region A collapsed retracted lung shadow as in simple massive pneumothorax, is not seen on the film

Small air cysts which cannot be differentiated from other air pockets such as localized pneumothorax at a single examination will maintain a more or less constant appearance while the others will show changes and later disappear

Based upon a study of reported cases and of their own observation the authors believe that congenital air cysts of the lung are fluid containing at birth and that their postnatal behavior depends principally on mechanical factors A classification of congenital lung cysts is suggested

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STUDIES IN PHYSIOLOGICAL AND PATHOLOGICAL UTERINE MUSCULATURE AT TERM

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UTERINE musculature at term presents a most interesting field for investigation yet there is very little to be found on the subject in medical literature. In order to appreciate the difference in the structure of normal and pathological uterine musculature such staining of the sections was utilized as to color the muscle fibers deep red and the connective tissue moderately deep blue. The staining method used for the preparation of the sections here presented is a modification of the axan method as described in Romels *Taschenbuch der mikroskopischen Technik* according to Heldenstein and Mallory but with shortening of the time of the staining with a marked increase in the tissue contrast. The following method was used.

The sections were prepared in paraffin. The slides were then deparaffinized by passing them through xylol, alcohol and water then into azocarmine¹ (muscle stain) and for 45 to 60 minutes kept in the incubator at 55 to 60 degrees centigrade removed from incubator and kept at room temperature for 5 to 10 minutes. (If the stain has been previously heated, the slides should be kept in the stain for only 15 minutes.) Following this, the sections were differentiated in alcohol aniline dye (1 cubic centimeter aniline oil to 1000 cubic centimeters of 90 per cent alcohol) for $\frac{1}{2}$ to 1 minute were stood in acetic acid alcohol solution (1 per cent acetic acid made in 90 per cent alcohol) for 3 to 4 minutes, and were then placed directly into 5 per cent aqueous phosphotungstic acid for 45 minutes and again washed with distilled water. The connective tissue was stained next by placing the slides in aniline blue orange² acetic acid for 45 minutes and again washed with dis-

tilled water following which they were differentiated in 90 per cent alcohol for a few minutes, in absolute alcohol xylol, and then mounted.

Careful studies in the arrangements of muscle fibers have been made by William Hunter in England Madame Boivin Deville and Helie in France Roederer Luschka, Henle Hoffman, Bayer Hofmeier and others in Germany but unfortunately their investigations have not led to uniform results.

The myometrium, a muscular coat, although composed of bundles of involuntary muscle arranged with little individual regularity may be considered as having an inner most circular layer a thick middle layer in which the bundles possess a general tendency toward figure-of-eight formation in a most irregular fashion of network of interlacing fibers, and a thin imperfect outer layer in which their course is for the most part longitudinal. However in the uterus there is really no uniform arrangement in layers such as circular or longitudinal as may be found in other organs. The interlacing and crossing muscle bundle in the thick middle layer is, according to Henle and Luschka, the main layer of the uterus and is a dense network of muscle fibers. This thick middle layer is distinguished by the intermuscular connective tissue being vascularized in all directions by blood vessels, and hence is known as the stratum vascular. This muscle layer is confined to the uterus except below where it becomes continuous with the muscle of the vaginal wall. The longitudinal muscle bundles of feeble outer layer which is present only over the fundus and body are continued beyond the uterus on to the tubes and into the broad, round, ovarian, and uterosacral ligaments.

The individual muscle cells are unstriated and of various shapes, usually elongated spindle shaped, or as rarely seen short and

¹Azocarmine B—1 cc per cent to 100 cc cubic centimeter glacial acetic acid and add up to two cubic centimeters water or acetic acid. 0.1 per cent boiled for 1 minute plus 1 cubic centimeter glacial acetic acid and filter water.

²Aniline blue orange acetic acid—aniline blue, 0.5 gram; gold orange G, 0.5 gram; water 100 cc cubic centimeters; glacial acetic acid 5 cc cubic centimeters—heat to boiling, cool and filter. Use dilute and with care.

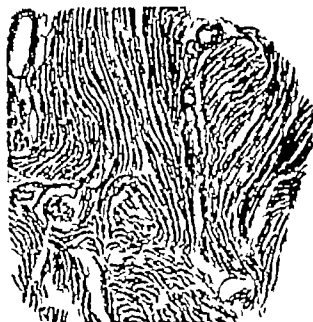


Fig 1 Uterus, caesarean section. Azan stain



Fig 2 Uterus, caesarean section. Azan stain

broad. In a few instances striated muscle fibers have been found in the uterus post partum near the placental site. Their length varies from 0.040 to 0.060 millimeters. On transverse sections the cells usually appear round, ovoid or polygonal, somewhat like a red cell but with the less defined outline and in many cells the nucleus is not on the plane section. The nucleus in the long diameter of the cell is ordinarily rodlike, but if fixed during the contraction is sickle or half moon shaped.

During pregnancy the enlargement of the uterus is not symmetrical but is marked in the fundal region. This can be readily appreciated by observing the relative position of the infundibula of the fallopian tubes and the ovarian ligaments which in the early months of pregnancy are almost on a level with the fundus, and in the latter months their attachments are found to point slightly above the middle of the organ. The increase in size and thickness of the walls of the uterus are brought about by combined hyperplasia and hypertrophy or increase in number of the individual muscle fibers. The position of the placenta also exerts a determining influence upon the extent of the hypertrophy; the portion of the uterus to which it is attached enlarging more rapidly than elsewhere, as is

clearly shown by the position of the uterine ends of the round ligaments which are close together when the placenta is inserted upon the posterior and far apart when it is upon the anterior wall. Postpartum the uterus is enlarged to a varying degree even if involution is complete. On section the musculature appears coarse and the blood vessels stand out

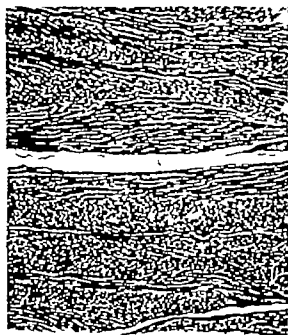


Fig 3 Uterus, caesarean section. Postmortem. No labor

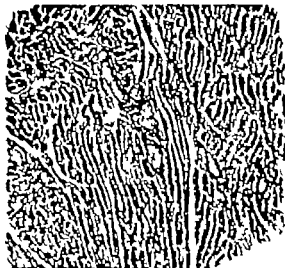


Fig. 4. Normal uterus postmortem. Azan stain.

above the surface. Microscopically there may be a preponderance of connective tissue and there is usually some lack of uniformity the involution being more advanced in some parts than in others.

In the uteri studied, the structure of the fibers was compared as to size, shape, and staining ability, and the amount of connective tissue was carefully noted. The low power magnification only is demonstrated. The fibers were measured as to the number per millimeter and at least ten fields were counted on each preparation and the average taken to determine the width of the fibers. The length could not be calculated as accurately.

Figures 1 and 2 are sections from uteri removed after cesarean sections. The muscle fibers are heavy, very long, and deep staining. There is very little intrafascicular connective tissue and a slightly greater amount of interfascicular connective tissue with an average of 22.4 to 30.5 fibers per millimeter respectively in the width.

Figure 3 is a section from a uterus, a cesarean section postmortem which was performed to get a living baby from a woman at term who was killed by a fall. She had had no labor pains. Here too the fibers appear to be very long and deep staining but thin. The intrafascicular and interfascicular connective tissue were both scant. The average width of the fibers is 36.7 fibers per millimeter.



Fig. 5. Placenta previa. Uterus, cesarean section. Azan stain.

Figure 4 is a normal postpartum uterus removed after death of the mother. The muscle fibers are very long and heavy as well as deeply staining. The transversely cut fibers are also very thick and there is barely enough intrafascicular connective tissue to be able to distinguish the individual fibers and there is a scant amount of interfascicular connective tissue. The average width of the fibers in this section is 25.4 fibers per millimeter. Figure 5 is a section from a uterus of a case of placenta previa. Here the musculature appears like that of the normal uteri removed after a cesarean section, and there is similar paucity of both intrafascicular and interfascicular connective tissue. The average width is 23.7 fibers per millimeter.

Figure 6 is that of a section of a uterus from a case of placenta accreta. The longitudinal fibers appear to be shorter and the transversely cut fibers smaller. There is not an equal staining throughout, many parts of fibers being only lightly stained. The average number of fibers per millimeter is 27.6 in their width. However, the number is proportionately greater because of a fair amount of intrafascicular connective tissue, with only a slight increase in interfascicular over the normal.

Figures 7 and 8 are two sections taken from the same organ, an atonic uterus, laboratory

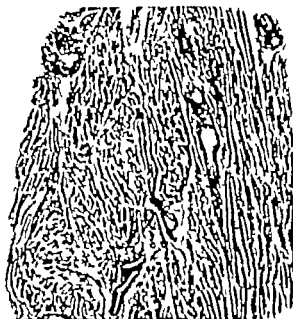


Fig 6 Placenta accreta. Uterus, cesarean section
Azan stain.



Fig 7 Atonic uterus.

protocol number 22627 The patient was a young woman aged 19 years a primipara. Menses had started when she was 17 years of age. After a normal pregnancy she had had a normal delivery followed by a severe bleeding before the placenta was expressed and this had to be done by the Credé maneuver. The vagina and uterus were douched with warm saline, the uterus massaged and a tamponade inserted into the uterus. An intravenous normal saline infusion was given, followed by a blood transfusion. In spite of all these measures the bleeding continued and the patient died 2 hours after delivery. Postmortem examination showed hyperplasia of the thymus gland. The ovaries were markedly hypoplastic. The uterine wall appeared thin, the inner surface entirely smooth without any placental tissue present. Postmortem diagnosis: atonic uterus probably due to status thymicolymphaticus.

Atonia is also spoken of as exhaustion of the uterine muscle. The Duncan separation of the placenta is thought to be a result, in most instances of uterine exhaustion thus causing the incomplete separation of the placenta and with it, the severe bleeding postpartum. Such a uterus is very large and soft, the muscle being entirely without tonus. Status thymicolymphaticus as presented in the above

case history has never been mentioned by any of the authors as a probable cause of atonia. However such a case is prone to have hypoplastic ovaries and also a uterus which is not well developed and with poor musculature. Causes which have been cited as capable of producing uterine atonia are those producing exhaustion of the nervous mechanism governing the uterine mechanism such as prolonged labor, loss of blood from antepartum



Fig 8 Atonic uterus.

hemorrhage emotional causes, improper co-ordination of the powers mental and nervous depression from severe pain anxiety or shock. Antonia due to any of the above causes is aggravated by toxemias of pregnancy Uteri which are characterized during labor by cramp-like pains accompanied by very weak contractions uteri which are affected by fibroids or uteri overdistended by polyhydramnios or multiple pregnancies almost always tend to be flabby postpartum

In Figures 7 and 8 the pathology of the fibers can be readily seen. The fibers are thin and short and have not a very good affinity for the stain. In some areas there is a slight amount and in other areas a vast amount of intrafascicular connective tissue but a very marked amount of interfascicular connective tissue is to be seen throughout. The average number of fibers in Figure 7 was 52.2 fibers and on another checking was found to be 52.5 fibers per millimeter. In Figure 8 the average number of fibers was 53.7 and another check ing was 54.2 per millimeter

TABULATED SUMMARY

Fig	Average number fibers (width) per mm	General characteristics		Amount of connective tissue	
		Length of fibers	Affinity of fibers for stain	Intrafascicular	Interfascicular
		Long	Good	Very little	Moderate
	20.5	Long	Good	Very little	Moderate
1	26.7	Long	Good	Very little	Scant
4		Long	Good	Very little	Scant
	7	Long	Good	Very little	Scant
6	27.6	Shorter	Fair	Much	Slightly greater than normal
7	52.2 52.5	Very short	Poor	Moderate	Much
8	53.7 54	Very short	Poor	Moderate	Much

The above tabulated summary gives in brief the important findings in the various types of uteri studied. normal uteri removed following caesarean section, normal uteri post partum a uterus removed in a postmortem caesarean section without labor uterus with placenta praevia, a uterus with placenta accreta, and an atonic uterus. The points com

pared are the number of fibers per millimeter the relative lengths of the fibers and their staining ability and the amount of intrafascicular and interfascicular connective tissue

Special thanks and gratitude are due Professor Doctor Oskar Frankl for allowing me free use of the material at his clinic and also for his invaluable advice

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CLINICAL SURGERY

FROM THE SURGICAL SERVICES, MASSACHUSETTS GENERAL HOSPITAL

A NEW MUSCLE SPLITTING INCISION FOR RESECTION OF THE UPPER THORACIC SYMPATHETIC GANGLIA

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SINCE 1929 the writers have performed 52 resections of the upper thoracic sympathetic ganglia through the posterior thoracic route which was first suggested by Henry on anatomical grounds for the relief of angina pectoris in 1922 and later modified and first performed by Adson who made it the standard operation for the relief of vasospasm in the upper extremity. In the beginning we performed the operation just as Adson described it but with increasing experience we have adopted a new type of skin and muscle incision. We believe that this new modification makes for a more anatomical type of incision that it gives a better exposure of the first or second rib and that it obviates certain postoperative complications which will be discussed below. We have performed this operation for a variety of peripheral vascular and other conditions which have been described in previous communications (6, 7, 8, 9). It is not therefore our object to discuss the indications for or the results of thoracic ganglionectomy at this time but to describe in detail the technique which we have found most satisfactory.

In the first 34 cases of this series a longitudinal incision was made in the skin exactly as described in Adson's papers (1, 2) for a bilateral sympathetic ganglionectomy; the incision was made in the midline from the spinous process of the seventh cervical vertebra down to the fourth or fifth thoracic; in the case of a unilateral resection a similar paramedian incision was made one to two fingerbreadths lateral to these spinous processes. With this approach one is forced to divide the trapezius muscle as well as the rhomboids and the serratus posterior superior directly across their fibers. We believe that such an incision is unanatomical because it produces considerable bleeding and also because muscles cut in this direction are difficult to heal. Furthermore in

using this approach it is necessary to employ prolonged forceful retraction of the muscles in order to expose and resect the first or second ribs. Such retraction traumatizes delicate muscle fibers and deprives them of their blood supply during the ensuing period of the operation. These factors plus the use of small rubber drains in some cases, were the cause of sepsis in 29.4 per cent of the incisions made by this approach. Sepsis of this type, while never serious, lengthened the hospital stay of these patients from 1 to 3 weeks and frequently resulted in the separation of the sutured muscles with an unsightly scar and weakness of the shoulder girdle.

In considering the best method of obviating these complications the writers' attention was directed by Dr. E. D. Churchill to an incision recommended by Head and Bigger for extra pleural thorocoplastics of the upper three ribs.¹ We have now utilized this approach in 18 cases with only one instance of wound sepsis which occurred in an epileptic who tore open his wound during a convulsion. All the wounds have healed with perfect apposition of the muscles which have only been divided in the plane of their fibers. Such a muscle splitting incision can be carried out with very little bleeding and the minimum of trauma to the muscles. Exposure of the first or second ribs is also facilitated by the direction of the incision as it parallels their course; furthermore a minimum of retraction is necessary. When the skin muscle incision has been made, resection of the proximal portion of the rib with its transverse process and exposure of the sympathetic ganglia is carried out in exactly the same way as in the operation which has been described by Adson.

¹Since this paper has been in preparation Dr. S. C. Harvey and Dr. A. W. Ouchterlony, of New Haven, have informed us that they have also developed a similar oblique incision from the suggestions of Head and Bigger.

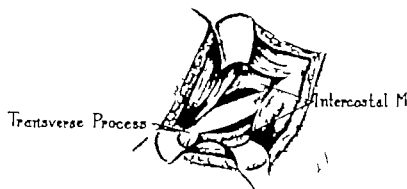


Fig. The insert shows position of patient on cerebellar table. Note that three pillows under thorax and low position of head-rest give good flexion of cervicodorsal spine. The inner sides of elbows and arms should be well padded to avoid pressure paralysis. The skin incision and separation of trapezius muscle fibers are shown. The insert also shows the orientation of the incision in the following drawings.

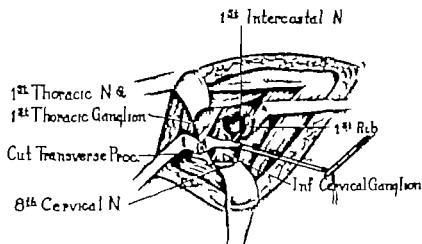


Fig. 2 The separated edges of the trapezius muscle are drawn back. The minor rhomboid has been separated from the levator anguli scapulae muscle, while the foriceps grasp one edge of the serratus posterior superior which is being split by the scissors.

TECHNIQUE OF OBLIQUE MUSCLE SPLITTING INCISION

The patient is anesthetized with nitrous oxide, oxygen and ether administered by a closed pressure apparatus to enable the lung to be expanded in case the pleura is opened. Intratracheal anesthesia is the ideal method if an anesthetist is available who is accustomed to its administration. Under these circumstances we advise avertin (tribromethyl alcohol) supplemented with nitrous gas, oxygen and ether. The patient should be

placed on a cerebellar type of operating table with the forward curvature of the head and neck exaggerated by placing three pillows under the chest (Fig. 1). This position serves to spread the upper intercostal spaces and to give the greatest possible abduction to the scapula. The skin incision is made starting a finger's breadth lateral to the spinous process of the seventh cervical vertebra and running obliquely downward and outward over the medial angle of the scapula. This incision need not be over 8 centimeters long. In the

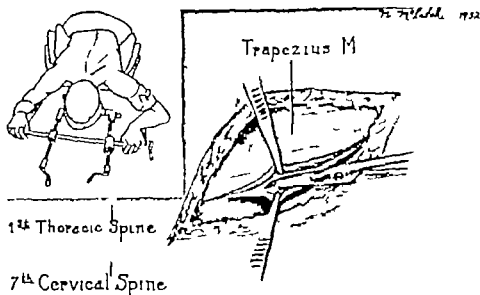


Fig. 3. All the muscles attached to the scapula have been retracted. The second rib shows in the lateral half of the field, whereas medially the rib and its transverse process are covered by the longitudinal band of the erector spinae group of muscles.

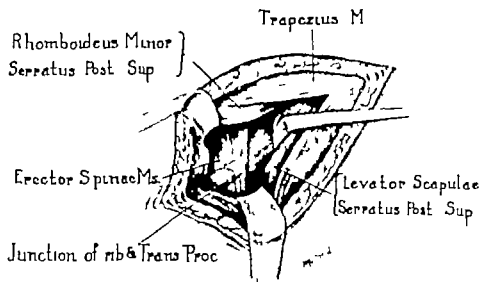


Fig. 4. Exposure of second rib after separation of intercostal muscles and underlying pleura. Note articulation with transverse process, which must also be removed. The first and third ribs barely show in the upper and lower edges of the incision, but by suitable mobilization and retraction of the muscles they can be adequately exposed and resected.

case of a bilateral operation, a similar incision is made on the opposite side but it is unnecessary to carry it across the midline. The cut is carried down to the deep fascia, bleeding points are ligated, and skin towels are applied. This oblique

incision runs nearly parallel to the fibers of the trapezius which are now separated by cutting through the fascia and stretching with the fingers. The fibers of the trapezius are then retracted upward and downward, thus exposing the minor

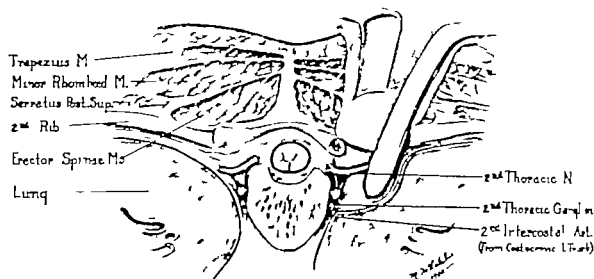


Fig. 5. Cross section of the thorax at the level of the second thoracic vertebra, to show the position of the sympathetic trunks.

rhomboid and levator anguli scapulae muscles (Fig. 2). Separation of these is again carried out by blunt dissection and the muscles then drawn apart by a pair of retractors. At this stage the upper ribs can be palpated, being covered only by the thin fibers of the serratus posterior superior muscle (Fig. 3). On splitting its fibers, the three upper ribs and the deep longitudinal back muscles are exposed. The attachments of these deep muscles are then separated from the transverse processes of the first and second ribs and drawn back by a medial retractor (Fig. 4). The resulting exposure gives ample room for resection of the proximal portions of any of the three upper ribs. Generally speaking we intend to remove a portion of the cervicothoracic sympathetic trunk extending from above the inferior cervical ganglion to below the second thoracic ganglion. It is easier to reach the upper portion of the trunk through the first rib and the lower portion of the trunk through the second rib. However, as a rule this portion of the trunk can be resected through either rib. Occasionally, in difficult cases, it is best to remove both.

It is important that at least the proximal 3 centimeters of the rib and the entire transverse process should be removed. The greatest care should be exercised to leave the pleura intact, but if a small opening is made it can frequently be closed by a small piece of muscle and the lung maintained in an expanded position by warning

the anesthetist to use positive pressure. As a general rule the patient's condition does not change but it is of the greatest importance to remember that certain types of opening in the pleura can allow more air to enter on inspiration than can leave on expiration. Even with adequate means of controlling the intratracheal pressure the operator must be constantly on his guard against such a valve type of opening and be ready to aspirate air from the chest if the patient's blood pressure falls or cyanosis develops. If the operator is on his guard the air can easily be removed with a large syringe and needle or through a rubber catheter inserted through the hole in the pleura and connected to the suction apparatus. Such a device should be always at hand. One of the writers had a case of sudden collapse from this cause in which over a liter of air was removed from the pleural cavity and the patient's condition immediately improved. Had this not been foreseen the patient surely would have died on the table.

After removal of the rib and transverse process, the pleura is separated from the body of the vertebra with blunt dissection. For this purpose, the operator's index finger is the ideal instrument. The pleura must be separated to a depth of 3 centimeters and can best be retracted by the use of a brain spoon. The best possible illumination is a requisite for this part of the operation. At this depth the sympathetic chain is usually seen run-

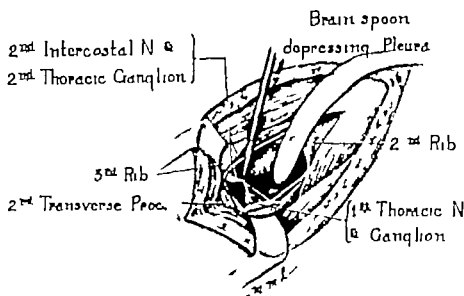


Fig. 6 Nerve structures seen after resection of second rib and transverse process.

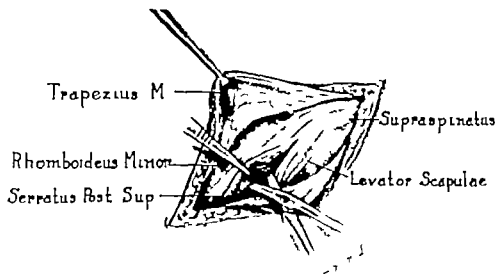


Fig. 7 Nerve structures seen after resection of first rib and transverse process. The cervicothoracic ganglion lies at a greater depth than is shown here, where it is depicted drawn up into the wound in order to show its shape and the relation of its rami.

ning longitudinally and adherent to the sides of the vertebral bodies. If it cannot be located in this way it can be found by search for the sympathetic rami which leave the second intercostal nerve and join the sympathetic trunk about a centimeter deeper down (Fig. 5). The communicant rami of the large first thoracic nerve, which crosses the upper end of the incision, can also be used as a guide to find the sympathetic trunk, as the first thoracic ganglion lies just beneath it. Once the trunk is located it should be drawn up on a nerve hook and followed both upward and downward by a blunt dissection (Fig. 6). Through

either a first or second rib resection it is possible with care and patience to follow the trunk downward and cut it beneath the small second thoracic ganglion. Then with downward traction and by successive cutting of the small sympathetic rami as they leave the trunk it should be possible to visualize two large ganglia higher up (Fig. 7). In our experience the stellate ganglion has usually consisted of two large and distinct components the lower and smaller of the two lying just beneath the large first thoracic nerve, the second and larger ganglion about a centimeter above. Rarely these two ganglia may be fused into a single struc-

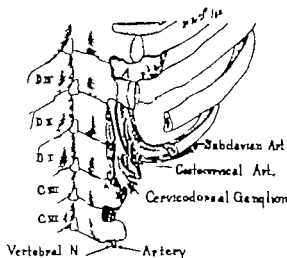


Fig. 8. Relation of the left cervicothoracic ganglion to the large arteries of the upper thorax. The descending branch of the costocervical artery which forms the first and second intercostals, may be either superficial or deep to the sympathetic trunk. The upper end of the inferior cervical ganglion lies on the vertebral artery. The subclavian lies considerably deeper and is not likely to be seen unless the pleura is widely reflected.

ture. It is well to appreciate that the inferior cervical and upper thoracic ganglia vary greatly in size, shape, and position, and that in no two cases are these structures identical. A large ramus usually joins the first thoracic ganglion to its spinal nerve, but occasionally the ganglion and nerve are fused (a condition we have encountered in 3 of our cases). For this reason it is extremely important to have a good exposure in order to avoid injury to the first thoracic nerve with resultant partial paralysis to the arm. Even handling of this nerve should be avoided as much as possible as this is a frequent cause of severe post-operative neuritis in the upper extremity. It is also necessary to remember that the cervicothoracic ganglion is in close relation to the large costocervical and vertebral arteries and to a lesser degree to the subclavian arteries (Fig. 8). Minor bleeding in this region is easily controlled by the use of dura clips, but an injury to the vertebral artery in this region would cause severe hemorrhage. After the large ramus joining the first thoracic ganglion to its spinal nerve is cut it is not difficult to draw the sympathetic trunk downward to a point where the inferior cervical ganglion can be safely dissected out.

The incision is closed tightly unless persistent oozing demands drainage. Otherwise we have found drains to be unnecessary and a frequent



Fig. 9. Scars of bilateral incisions. From a photograph taken 14 days after operation on the right side 7 days after operation on the left.

cause of infection. As the retractors are removed, the muscle edges fall together and require only a few interrupted catgut sutures for perfect apposition. A row of interrupted sutures through the deep fascia of the trapezius, and silk sutures in the skin complete the operation. The best dressing consists in silver foil covered with gauze sponges, which are held in place by crucial strips of adhesive running over the shoulder.

In this operation postoperative shock almost never occurs unless an extensive pneumothorax is allowed to develop through opening the pleura. Such an accident can usually be avoided by taking sufficient time in resecting the rib (especially in the second rib approach), and in using careful, slow blunt separation of the pleura from the bodies of the vertebrae. Even if a pneumothorax occurs, serious complications can be avoided by its early recognition and thorough aspiration of the air. Although the patient usually shows no change in blood pressure or pulse rate, we have felt that even under the most favorable circumstances the bilateral operation should be done in two stages. With the oblique muscle splitting incision all skin sutures can be removed within a week and the operation performed on the opposite side at the end of this interval. As neither incision is carried to the midline the previous scar can be completely covered with the skin towels at the time of the second operation. Postoperative discomfort lasts only a few days and the patients need not be kept in bed over a week. The usual appearance of the bilateral incisions, 7 and 14 days after operation, is shown in Figure 9.

SUMMARY AND CONCLUSIONS

As the result of the recent growth in understanding of the sympathetic nervous system the

more accurate knowledge of the ganglia which must be removed to produce a given effect and the development of improved diagnostic methods the indications for thoracic sympathectomy have been greatly enlarged. The increasing importance of this procedure has led us to report a new oblique muscle splitting incision which in our hands has avoided much unnecessary bleeding and trauma of the large muscles of the back. As the result of this slight technical improvement, wound healing has been greatly accelerated, sepsis and separation of the divided muscles has been practically eliminated and access to the upper ribs and their underlying ganglia has been facilitated.

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FROM THE UNIVERSITY OF MICHIGAN HOSPITAL

TOTAL PULMONARY LOBECTOMY¹

A SIMPLE AND EFFECTIVE TWO STAGE TECHNIQUE

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CERTAIN cases of bronchiectasis and multiple pulmonary abscess can be cured only by total removal of a lobe of the lung. The exceptional difficulty of the technical problems connected with total lobectomy is evidenced by a 53.4 per cent mortality in 127 cases that I have collected from the clinics that have not been importantly connected with the relatively recent advances in technique. Another series of 115 cases with a mortality of 21.5 per cent has been collected from the four clinics in the United States and the four in Canada and Europe that have been chiefly responsible for the present hopeful outlook for a steadily declining mortality rate and an increasing proportion of truly complete cures.

The present justifiable optimism is especially gratifying in view of the statements made by Samuel Robinson (26) in the presidential address before the 1922 meeting of the American Association for Thoracic Surgery. He said, after presenting what is undoubtedly one of the most pessimistic descriptions of the difficulties of an operation that has ever appeared in print that "It has always been my belief that the greatest triumph in thoracic surgery will be the surgical eradication of this deplorable disease (bronchiectasis). Tuffier in 1924 said that he had never completely cured a case of pure bronchiectasis. Archibald in 1927 wrote that the problem of lobectomy is chiefly concerned with the question of operative mortality and that it will be solved when the mortality has been reduced to 20 per cent or even less.

In this article I shall consider critically the various techniques that appear on the basis of results and theory to have the greatest promise. I shall present in detail a simple operation that seems to me to make more effective use than does any other of safeguards against the complications of shock, primary and secondary hemorrhage pneumonia overwhelming infection of the pleura and mediastinum mediastinal emphysema, bacteremia, tension pneumothorax and mediastinal "flutter" which have been the chief reported causes of death after lobectomy.

Briefly, this operation consists, at the first stage in resection of the posterior portions of the sixth, seventh, and eighth ribs, separation of the dis-

eased lobe from any pleural adhesions, gentle stroking with gauze of the parietal and visceral pleura of the whole hemithorax in order to create a protective inflammatory barrier against subsequent infection and to cause the undiseased lobe to become adherent and the placing of an air-tight drain. At the second stage 9 to 12 days later, the incision is reopened, only the diseased lobe is freed from its new adhesions and the hilum of the lung is tightly ligated with silk and a rubber tube and the lobe is left in place until it comes away spontaneously. The incision is closed temporarily or if the mediastinum is rigid it is left wide open.

I have personally performed 18 total lobectomies with 3 deaths (16.6 per cent). Two of these operations were performed early in my experience by a technique (one stage in the presence of a non-adherent undiseased lobe) that I soon learned to consider as unsound and one of the patients died. The remaining 16 had adhesions over both the diseased and undiseased lobes at the time the lobectomy phase of the operation was carried out and 2 (12.5 per cent) died. Twelve patients (Table I) had few or no adhesions over the undiseased lobe at the time of the first of a two stage operation performed according to the most important of the principles that will be discussed, and 2 (16.6 per cent) died. Only the last 6 of these 12 received in more or less full measure the benefits of the operative technique that has finally been developed and none of them died. The results can now be judged in 11 of the 12 patients: all of the 9 living patients (81.8 per cent) are either completely cured or improved.

INDICATIONS

This article is concerned with total lobectomy as indicated for the common central type of bronchiectasis or for extensive multiple pulmonary abscesses, perhaps associated with bronchiectasis, and without inseparable pleural adhesions. It should also be useful for pulmonary neoplasms that do not require complete resection of the lobar bronchus for those that do I believe that the technique to be described by Churchill (12) is better.

Consideration will not be given to partial lobectomy as indicated for extracental cavernous

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lesions involving the parenchyma and bronchial. There are frequently extensive pleural adhesions over such lesions and in this type of suppuration I have found the Fovats Graham partial cautery lobectomy to be of great value. Graham (5) has used this operation in 54 patients with only 6 operative deaths (11 per cent). The partial lobectomy advocated by Brauer seems to me less safe.

Elsewhere Alexander and Buckingham have discussed somewhat fully the management of various types and phases of non tuberculous pulmonary suppuration and considered the indications for total lobectomy. Briefly the patient and particularly his cardiocirculatory system must be in reasonably good condition and his disease should be known to be confined to one lobe as determined by lipiodol roentgenograms of all five lobes. In 4 of the 18 cases reported in this article lateral and anteroposterior bronchograms in which lipiodol appeared to have entered the upper as well as the lower lobe seemed to indicate that the lesions were confined to the lower lobe and yet, after basal lobectomy, additional bronchograms showed that there remained bronchiectasis in the upper lobe. This diagnostic mistake was occasioned by either of two errors: (1) Bronchiectasis which appeared in the postero-anterior bronchogram only as high as the fourth rib posteriorly was interpreted as occupying the apex of the lower lobe whereas it was actually in the mid portion of the upper lobe. The lateral bronchograms were of relatively little value at this high level. (2) Bronchiectasis which appeared in the lateral bronchogram in the left lower midaxillary line was interpreted as occupying the anterior portion of the lower lobe whereas it actually occupied the lingula of the upper lobe (first ventral branch of the upper lobe bronchus). The corresponding involvement on the right side is of the middle lobe and is more readily diagnosed in a lateral bronchogram.

Certain therapeutic measures should be given adequate trial for months or even a year or more, before a decision is made to perform a lobectomy. Most important among these are phrenicectomy (perhaps temporary phrenic nerve interruption is preferable, as suggested by Churchill (11) a modified sanatorium regimen postural drainage every 2 or 3 hours during the patient's waking hours, conservative treatment of sinus ear and mouth infections, one or more courses of bronchoscopic aspirations and possibly intravenous neosalvarsan injections. Some or all of these measures were used in each of the cases reported in this article before a decision to perform a lobectomy was reached.

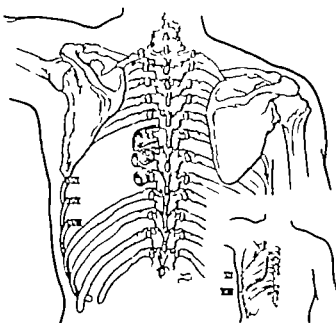


Fig. 1. Indicating extent of ribs resected for basal lobectomy and relation of operative window to hilum of lung. Inset shows position of incision.

THE OPERATION

Pre-operative management. In the technique about to be described it is important that the sixth, seventh and eighth ribs be exactly identified for resection because they immediately overlie the hilum of the lung. It is therefore necessary to know before the operation is begun whether the lowest rib that is palpable in the loin is the eleventh or the twelfth so that a beginning may be made for an accurate count upward. This knowledge may be got either from a roentgenogram that shows all of the ribs or by counting the ribs, before the patient is draped downward from the readily identified second opposite the angle of Louis.

Shortly before operation the patient empties his lung of secretions as completely as possible. A small dose of pantopon or morphine without atropine is given before operation.

The patient is placed on his good side on the operating table in not less than 15 degrees Trendelenburg position. I rely upon this position and occasional aspiration of secretions from the mouth rather than upon intratracheal aspiration through a tube which, I believe dams back some of the secretions at the rima glottidis. The Trendelenburg position helps the secretions to gravitate toward the mouth and light doses of morphine and nitrous oxide do not abolish the cough reflex. These important precautions reduce the chance of postoperative pneumonia, this complication occurred only once among my patients and in that instance was not fatal.

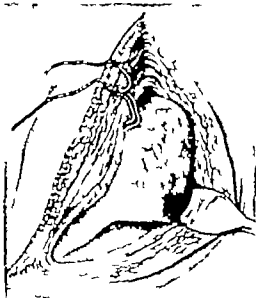


Fig. 2 Simple encircling ligature of hilum of lower lobe is about to be tied close to pericardium. This is done by touch because even the partially deflated lobe obscures the hilum. For clarity the drawing shows the lobular pulmonary markings and the layers of the wound in the thoracic wall. Actually these are hidden at this stage of the operation by the traumatic inflammatory reaction produced by the first operation.

First stage Local anesthesia is used until the pleural cavity has been opened, and then light positive pressure nitrous-oxide-oxygen is given through a snugly fitting mask. The incision for the usual basal lobe lobectomy is made from the angles of the fifth to the ninth ribs and then over the eighth intercostal space to the posterior axillary line (Fig. 1). If the cutaneous incision is made more posteriorly the sacrospinalis muscle will be left bare after the second stage. The sixth, seventh, and eighth ribs and the sixth and seventh intercostal bundles are resected from the very tips of the vertebral transverse processes to the posterior axillary line. The parietal pleura is widely incised and if pleural adhesions over the diseased lobe seem probably separable the bare sheet of parietal pleura is cut completely away between the fifth and ninth ribs and between the transverse processes and the posterior axillary line, so as to give free access to the lung. Its retention would serve no purpose. Rib spreaders are placed.

It is not possible to tell before operation how extensive pleural adhesions are unless a pneumothorax is induced and this is usually inadvisable (yet Brunn (8) has found it advantageous in ex-

pulling secretions before a lobectomy operation) because of the danger of a complicating empyema. Furthermore a pneumothorax would be unable to show whether or not adhesions, if present, might be separated surgically. The diseased lobe of my last patient was completely invested in adhesions, most of which were broken without difficulty by the fingers. The fingers are used to rupture only such delicate adhesions as would not cause even tiny tears in the lung with possible resulting pleural infection, which would certainly be a grave complication at this stage. Adhesions in the interlobar fissure are usually firmest at its costal surface and I have found it useful to open the fissure sufficiently to admit a finger into the interlobar space the finger can usually easily separate the lobes up to the adhesions between them at their costal surfaces and these may then be divided accurately and quickly with scissors. Scissors should be used to divide other tough adhesions which are frequently met in the costovertebral gutter and between the lung and diaphragm and occasionally between the lung and pericardium. The upper lobe is usually free of adhesions. If as occasionally happens, the adhesions investing the diseased lobe are very tough and extensive and their division is difficult and slow I believe that the operation should be abandoned and Graham's cantury pneumonectomy resorted to. I lost a patient because of unwisely attempting to divide such adhesions.

The free edge of the pulmonary ligament should be divided with scissors and the rest of the ligament safely torn with a finger up to the inferior pulmonary vein. The less accessible portions of the pleural cavity may be better exposed by very gently retracting part of the lobe held by one or two Duval pulmonary forceps which occlude working space far less than a retracting hand.

In bronchiectasis of the large central bronchi without complicating infection and induration of the pulmonary parenchyma, the diseased lobe may be soft and have a normal appearance. In fact, a distinguished thoracic surgeon has reported that he mistook this phenomenon once so confused him that he mistook the diaphragm for the diseased lobe (which was non-adherent) and began to dissect it from the thoracic wall before he discovered his mistake. On the contrary fibrous pneumonia may cause such shrinkage of the lobe and compensatory emphysema of the neighboring lobe or lobes may so cover the diseased lobe, that its identification may be momentarily difficult.

The next step in the operation is very gentle stroking of every portion of the mediastinal, costal, diaphragmatic, and visceral (except that of the

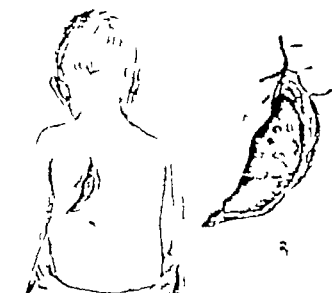


Fig. 3. About 3 weeks after total basal lobectomy in 5 year-old boy. At right, detail of wound. The great pleural hole that was occupied by the lobe has rapidly decreased by expansion of upper lobe, rise of diaphragm (q.v.) and slightly by displacement of mediastinum. Two bronchial mouths are plainly visible. The small opening below the main wound is where air tight drainage tube had been placed at bottom of costophrenic sinus, which has now become obliterated by adhesions.

diseased lobe) pleura with dry gauze held on the fingers. Especial attention should be paid to the region of the hilum and to the visceral and parietal pleura of the undiseased lobe. The dome of the pleura may easily be reached through the operative wound.

Three objects of paramount importance are attained by stroking the pleura

1. A sterile traumatic inflammatory exudate is produced on and under the pleura which exudate serves as a protective barrier against the infection that will inevitably occur within the pleural cavity after the second stage of the operation. This barrier tends to prevent the virulent phlegmonous type of pleural infection which may be complicated by mediastinitis and septicæmia, that has occurred with fatal results in so many reported cases of lobectomy in which the highly virulent organisms of the bronchiectatic secretions have been allowed to come in contact with a wholly or inadequately prepared pleura. Everts Graham, in 1923 recognized the importance of creating a leucocytic wall in the mediastinal pleura and of causing the undiseased lobe to become adherent before the diseased lobe was removed he used Robinson's gauze packing around the diseased lobe and left a clamp on the hilum for 3 or 4 days after the lobe was resected but apparently he was dissatisfied with the method and abandoned it.

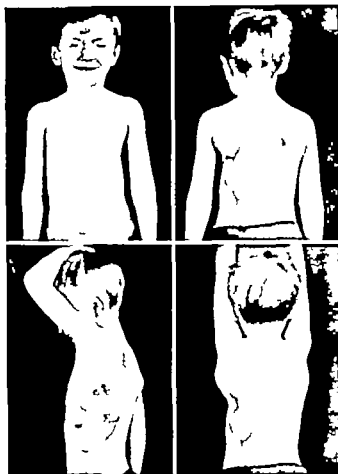


Fig. 4. Boy 5 years old, after solid closure of wound following total basal lobectomy 6 months ago. Incision below main scar was made to obtain pedicled latissimus dorsi graft to close bronchial fistula. Dotted lines in lateral view represent original outlines of lower lobe.

2. During the 10 or 12 days that intervene between the first and second stages of the operation the traumatic pleuritis results in firm adhesion between the entire lung and its investing parietal pleura. At 10 or 12 days these adhesions are not so well organized as to prevent manual separation of the diseased lobe for the purpose of the operation and yet they are sufficiently firm to hold the undiseased lobe snugly to the thoracic wall. This fixation of the undiseased lobe limits the empyema that develops after the second stage to one half of the pleural cavity and thus empyema cavity becomes obliterated spontaneously. If the empyema should occupy the entire pleural cavity, as it does after a one stage lobectomy in the presence of a non-adherent undiseased lobe if pleural infection occurs, it would be a grave and perhaps fatal complication, especially in view of the large bronchial fistula that is usually present after removal of the lobe. Such an empyema is not likely to become cured spontaneously and may eventually require

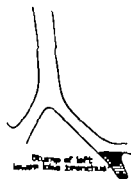


Fig. 5

Fig. 5 Tracing of trachea and main bronchi from bronchogram of child made after closure of wound following left basal lobectomy. Iodized oil has temporarily collected in stump of left basal bronchus.

Fig. 6 Roentgenograms after solid healing of wound following total left basal lobectomy. Space once occupied by lower lobe has been filled by expansion of upper lobe and



Fig. 6

rise of paralyzed hemidiaphragm and slightly by displacement of mediastinum and depression of soft parts into defect left by removal of posterior portions of sixth, seventh, and eighth ribs. Arrows on postero-anterior exposure indicate the medial ridge of the closed thoracic wall defect and the arrows on the lateral exposure indicate the risen diaphragm.

extensive, dangerous, and deforming Schede thoracoplastic operations.

3. A vitally important effect of having caused firm adhesion between the undiseased lobe and thoracic wall is stabilization of the mediastinum, which is contributed to by the stiffening of its pleura and subpleural tissues that follows gauze stroking of the mediastinal pleura. Stabilization of the mediastinum prevents the mediastinal shift to the opposite side and the flutter that have been responsible for the fatal outcome of so many reported lobectomies.

I feel that the method I have just described for treating the pleurae is the chief cause of the success of my lobectomies. It is the outcome of a series of experiments that I performed on 16 dogs in 1921. I was stimulated to carry out this work by reading the sound opinions published by Samuel Robinson in 1917 and by a letter received from him in February 1921 in which he encouraged me to try to find a solution to the pleural problems.

From these experiments I found that the most effective method that I used to cause pleural adhesions was by rubbing the pleurae with gauze and lightly scratching them with the tip of a needle or scalpel. This sometimes caused traumatic pneumonia and sometimes the scratching allowed air to escape from the lung which would have been dangerous if the lung were severely infected. In man, therefore, I did not scarify and instead of

rubbing the pleurae I gently stroked them and no pneumonia or pleural infection have resulted (except the contralateral non-fatal case already cited). In dogs I found that neither pneumonectomy or treatment of the pleurae with such chemicals as tincture of iodine, 0.5 per cent silver nitrate, 20 per cent Sudan III in liquid paraffin, and ether was satisfactory. For example, in one dog 7.5 cubic centimeters of 73½ per cent tincture of iodine introduced into one open pleural cavity caused death in less than 1 minute from what appeared to be true pleural shock. In another dog 5 cubic centimeters caused death in 11 days from a violent pleuritis and pulmonary congestion and edema. Three cubic centimeters of 0.5 per cent silver nitrate caused death in about 22 hours from a hemorrhagic pleuritis and congestion and edema of the lungs. Because of such results as these I feel that gently stroking the pleurae is safer than the use of chemicals, although it is true that the amounts used were relatively greater than would be used in man and that a dog's lung is more delicate than a man's. Lillenthal in his book published in 1925 described roughing the pleurae with gauze and painting with tincture of iodine but found that firmer adhesions were formed if iodoform gauze strips were laid over the undiseased lobe and withdrawn 48 hours later. Robinson (23, 24) attempted with only partial success to obtain mediastinal adhesions and fixation by packing

gauze around the diseased lobe at the second stage of a three stage operation, if the patient's condition made completion of the operation in two stages inadvisable. Everts Graham (16) used the same method.

Stroking the pleura with gauze causes a traumatic effusion, totaling from 400 to 1000 cubic centimeters or more, which must be aspirated several times during the following week if tube drainage is not used. Some of the fluid often becomes encapsulated in various portions of the pleural cavity and, therefore is not removed by thoracocentesis in one place. If one of the pockets is between the undiseased upper lobe and the thoracic wall and is opened at the time of the second stage operation a partial upper thoracic empyema results and complicates convalescence. Therefore, in order to provide constant rather than intermittent, drainage for the effusion that forms and for whatever air may have been trapped in the pleural cavity, as the wound was closed I shall in my next patient (in the past I have used drainage only after the second stage) introduce a fenestrated rubber tube 10 centimeters into the pleural cavity through the intercostal space that lies over the bottom of the posterior costophrenic sinus and couple this tube with a long tube whose free end will be kept anchored beneath sterile solution in a bottle under the patient's bed. So that this drainage system will remain absolutely air tight until several days after the second stage of the operation the tube should be introduced through the thoracic wall by making a stab wound no wider than the diameter of the tube, after the skin and extracostal muscles have been pushed far upward. The tube should be drawn through the stab wound by a haemostat and when the extracostal soft parts slip down over the tube this will then pass quite obliquely through the thoracic wall, thereby importantly helping to prevent sucking of air into the thorax around the tube.

The next step in the operation is to close the latissimus dorsi and rhomboideus major muscles with an interrupted continuous stitch of No. 1 chromic catgut, and the skin with interrupted silk without direct drainage of the wound. Just before the last knot of the muscle stitch is tied the anaesthetist completely expands the lung by raising the gas pressure. A vaselined dressing is placed and the incision is well supported by an elastikon dressing.

As the patient awakes from the gas anaesthetic he is made to expectorate all loose secretions from his mouth and tracheobronchial tree before he is changed from the Trendelenburg position on the operating table.

The systolic blood pressure increased during the operation an average of 21 millimeters in all of the patients operated on according to approximately this technique except that in 2 patients it dropped 28 and 20 millimeters. There was an average increase in pulse during the operation of 14.3 beats per minute. The average complete operating time was 63 minutes.

Postoperative management (first stage) Such doses of opiates should be used as to relieve pain sufficiently to make the patient willing to cough and yet not large enough to abolish his cough reflex.

Postural drainage should be continued throughout the interval between stages and should be begun within 2 or 3 hours after operation, and inhalations of carbon dioxide and oxygen should be given if needed to aid coughing and expectorating. Occasionally I have used postural drainage immediately after operation by placing the operating table in full Trendelenburg position or by inverting the patient over the edge of the table if he is unable voluntarily to expectorate his loose secretions.

Following operation the blood pressure is usually well maintained, but for several days the pulse is likely to be rapid, and occasionally is as high as 148 and even 158 and the respiratory rate is usually moderately increased. The temperature does not reach 101 degrees and as a rule is considerably less. Usually my patients get out of bed for a few minutes 8 or 10 days after operation.

The second stage should be performed 9, 10, 11 or 12 days after the first stage. If performed sooner than 9 days the pleural adhesions of the undiseased lobe are not likely to be strong enough to keep this lobe from retracting from the thoracic wall, whereas after 12 days the adhesions of the diseased lobe may be too tough to permit their rupture by the operator's fingers. If 3 or even 4 weeks were allowed to elapse between stages, instead of 10 or 12 days, the pleura would be still thicker and a correspondingly more effective barrier would exist between the body and the empyema that follows the second stage operation, and the mediastinum would be still more rigid and undoubtedly sufficiently so to make it perfectly safe to leave the thoracic wall wound wide open after the second stage. This would be of advantage in controlling infection as the gangrenous lobe could be packed off with acriflavine gauze every 24 hours, or even every 12 hours, whereas this is not done for 2 or 3 days if the incision is temporarily closed. I believe that such an interval between stages would be feasible if at the time of the first stage the diseased lobe were completely

surrounded by rubber dam (Lilienthal 18) in which there were several small dependent holes for escape of fluid, in order to prevent its adhesion to the parietes. I shall use this modification for my next lobectomy patient. Additional advantages of this will be considered in the next section.

Second stage. Pre-operative postural drainage and medication and the position of the patient on the operating table are the same as have been described for the first stage. Slightly positive pressure nitrous oxide oxygen anesthesia is used so as to keep the newly adherent undiseased lobe from retracting from the thoracic wall. If there had been a three or four week interval between stages positive pressure would be unnecessary.

With the fingers the incision is reopened and the diseased lobe is completely freed from its adhesions. The oblique main interlobar fissure must first be identified beneath the pleural exudate so as to avoid freeing any of the undiseased lobe. It should be remembered that the normal sized lower lobe is of great height, extending from the fourth to the tenth or eleventh ribs in the para-vertebral line (Fig. 4).

A liver needle threaded with 80 centimeters of very heavy braided silk of great tensile strength and which has been boiled only once is held in the fingers, rather than in a needle holder, for greater delicacy of touch and is passed without force through the hilum of the diseased lobe close to the pericardium. Here the hilum is about 3.5 centimeters broad and the needle passes through it at approximately the junction of its upper quarter and lower three-quarters. The needle should not and probably does not pass among the great vessels and bronchus but above them, through the lower part of the web of parenchyma that lies between the lobes.

After the needle has been passed, the silk is divided at its middle and one half is then tied with a surgeon's knot as tightly as possible around the upper part of the hilum and the other half around the lower part. Each pair of ligatures is then made to encircle the whole hilum and is tied tightly.

The method of hilar ligation just described is the one that I have used until now. When, in my earlier cases, the ends of the tied ligatures were passed through the latissimus dorsi muscle in order to exteriorize the lobe, it was important that a transfusion ligature be used to prevent slipping. But as I no longer exteriorize the lobe nor resect it immediately after ligation, this is not necessary. Two or three superimposed simple encircling ligatures of heavy braided silk with surgeon's knots (Fig. 5) should be as effective as a transfusion ligature and be without the potential danger of the

latter. Encircling ligatures placed close to the pericardium of a fresh cadaver did not tend to slip distally. I shall use them for my next patient.

On several occasions I found that these tight ligatures of the indurated hilum did not completely shut off the blood supply to the lobes which remained partially viable and later needed to be removed with the actual cautery, in one or more stages, between which in one patient, there was a small hemorrhage from the stump. I have heard of one and possibly two sudden deaths that were apparently due to resection of the lobe with an electric cutting current.

On two or three occasions I found that the ligatures occluded the pulmonary vein but not the artery and wet rather than dry gangrene resulted with great exudation of blood into the lobe and leakage of much bloody serum from it, requiring blood transfusion. In these patients the artery was closed by ligating the hilum, the lobe still being in place, with a live rubber tube (Lenharts). It may be necessary to retie this tube more tightly each day for several days. In the future I shall apply this elastic ligature during the second stage operation, immediately after ligating with silk. I doubt if the elastic ligature alone could be counted upon immediately to occlude both artery and vein, unless the hilum were first tightly tied with silk.

In none of my patients has there been any known reflex cardiac or respiratory disturbance from tight ligation of the hilum close to the pericardium and in only the first 1 or 2 cases did I first inject procaine around the hilum. I have crushed the hilum before ligating in only one case and there was no ill effect, but since then I have felt that the risk of causing a fatal reflex or of fracturing a part of the hilum was greater than the obvious advantage of crushing the infiltrated hilum so that the ligatures would more surely occlude the vessels and bronchus. Morrison found in experimenting upon rabbits that crushing and ligating the hilum of one lobe caused no important reflex disturbance but that crushing the whole hilum of a lung caused almost immediate death unless the vagus nerve had been divided or blocked. He states that other experimenters found that this reflex did not occur if the whole hilum had been only ligated and not crushed.

I feel very strongly that it is better not to cut away the lobe after ligating its hilum but to leave it until it spontaneously separates at the line of demarcation at the ligatures, from 10 to 20 days after operation, or at least not to cut it away until a week or 10 days after operation. It is, of course, unpleasant to have a pulpy gangrenous lobe attached to the body for days but there are two very

real dangers of removing the lobe during the first postoperative week. If the hilar ligatures have not completely closed the vessels and bronchus these will leak blood, bronchial secretions, and air into the pleural cavity and the leakage of air might cause a fatal tension pneumothorax if the thoracic wall incision were closed and if the drainage tube should have become plugged. Even if the hilar ligatures completely occluded the vessels and bronchus at the time of removal of the lobe, there is a tendency for the ligatures to loosen because of pressure necrosis of the ligated tissues and because of the infection that is present in the hilar stump. A fatal secondary hæmorrhage or embolus to the brain or tension pneumothorax might be the result. Garré and many others who amputate the lobe ligate separately any vessels they find on the cut surface of the stump to help to avoid the danger of secondary hæmorrhage. It seems likely that there is a better chance of the thrombi that form in the vessels becoming solidly organized if the blood vessels are not cut across and their open lumens directly exposed within a week of the hilar ligation. The ligatures around the blood vessels are not a permanent barrier of protection to the thrombi central to the ligatures against the infection in the thrombi distal to the ligatures. Infection of the thrombi central to the ligatures would of course expose the patient to the dangers of secondary hæmorrhage embolism and bacteraemia.

It seems reasonable to assume that primary resection of the lobe, with the considerable manipulation of the stump that the ligations and layered suture entail, exposes the patient to greater danger of embolism and brain abscess than if the hilum were merely ligated. Two of 46 patients operated on by several surgeons according to the Shenstone technique died from brain abscess.

Whittemore (36, 37) in a one stage operation deeply sutures the lung, as near to the hilum as possible to the extracostal muscles (and occasionally also ligates the hilum with a catheter) thereby steadying the mediastinum and as the lobe is not removed during the operation allowing infection to set in gradually. He has had 3 deaths among 10 patients. The fundamental principles of the Whittemore operation appeared to me as sound but my early actual experience with it dissatisfied me and I lost one of the two patients for whom I used it. My chief objections to it are these: (1) Infection of the entire pleural cavity is almost inevitable within a week of operation, by which time the sutures uniting the lung and extracostal muscles will have loosened, allowing the infected lung to slip into the pleural cavity which has not been

adequately prepared for so severe an infection. And as the undiseased lobe has scarcely had time to become firmly adherent to the thoracic wall, or the mediastinum to become fairly rigid, the open pneumothorax, that occurs when the lung retracts from the thoracic wall may prove fatal in itself or through a pneumonia which such a pneumothorax favors. (2) Even the partial exteriorization of a lobe without the addition of a quite extensive thoracoplasty to cause the thoracic wall to drop well inward, produces traction upon the heart and great vessels of the mediastinum (Bolgiano Patek and Sailer, Sauerbruch and Robinson). It is difficult for the surgeon to predict whether or not the traction that he exerts upon the mediastinum in fixing the lobe in a more or less exteriorized position will cause dangerous disturbances of the cardiocirculatory system. In 2 of my patients I felt within 48 hours of operation that the traction was too great and so cut the sutures that were holding the partially exteriorized lobe to the thoracic wall.

In most of my two stage lobectomies I have exteriorized the lobe at the second operation. However, during recent months I have felt that in view of preparation of the pleura for infection and against "mediastinal flutter" at the first stage that exteriorization of the lobe at the second stage was not only potentially dangerous but entirely unnecessary. Therefore, in my last two patients I left the diseased lobe after ligation of its hilum in the pleural cavity and closed the thoracic wall incision tightly leaving an air tight drainage tube in the position described under "first stage." My present technique, therefore has no relationship with the Whittemore technique.

The wound in my last two patients was closed airtight so as to protect them against any harmful respiratory mediastinal movement that might possibly have occurred during the first 2 or 3 days after operation if the incision had been left open, because the gauze stroking of the mediastinal pleura 12 days before might not have sufficiently stiffened it. A catheter, whose outer end was clamped, was introduced into the lower pleural cavity alongside of the lobe for intermittent installations of Dakin's solution. Two or 3 days after operation which was 2 or more days before the bronchus might be expected to open spontaneously, the incision was completely reopened, as had been intended, and the pleural space around the gangrenous lobe was loosely packed daily with acridavine gauze until the lobe was removed about a week later. This procedure proved to be entirely satisfactory. Theoretically it would be preferable not to close the incision at all after the second

operation but to keep the lobe available for inspection at any time so as to detect at once signs of wet rather than dry gangrene, any bleeding from the crushed hilum where it was crushed by ligation and also to eliminate the possibility of a tension pneumothorax that might arise from a known or unknown opening of any part of the lung. With a closed incision, bleeding would be detected and a tension pneumothorax prevented if the air-tight drainage tube were open but, if the tube had become plugged the diagnosis might be made too late. I believe that it will prove perfectly safe to leave the incision wide open after the second operation is completed if 3 weeks are allowed to elapse between the first and second stages so as to give the mediastinum plenty of time to become quite rigid. This interval of time should be possible if the lower lobe is surrounded by rubber dam at the first stage operation. The advantages of a 3 week interval between stages and of leaving the wound open after the second stage so as better to control infection were discussed in the last paragraph of the section, "post operative management (first stage)."

The patient is made to cough and expectorate before the Trendelenburg position of the operating table is changed.

The majority of the second stage operations have been performed in 35 minutes or less, from beginning to end. In most of the patients the systolic blood pressure was higher at the end of the operation than at the beginning; in the rest the drop was 10 millimeters or less, except that in one patient it dropped from 126 to 112. The pulse rose during the operation from an average of 124 to 130. The greatest increases were from 112 to 168 which 2 hours later was 136 and from 135 to 164, which 5 hours later was 120. There was usually an increase during operation of 10 or 20 and occasionally even more in the respiratory rate which decreased slowly during the following days.

Postoperative management (second stage). Opiates and carbon-dioxide inhalations are given as after the first stage and regular postural drainages are used for at least several days until normal expectoration can be counted upon to clear the lungs of secretion and thereby reduce the chance of pneumonia. For a day or so the sputum may be somewhat bloody due to trauma to the bronchial mucosa by the hilar ligatures. Installations of 60 cubic centimeters of Dakin's solution through the catheter are begun immediately after operation and continued every 2 hours until the incision is reopened 2 or 3 days later when acriflavine gauze, in which several Dakin's tubes are held, is snugly packed around the gangrenous lobe and re-

newed every 12 or 24 hours. Acriflavine solution is instilled into the Dakin's tubes rather than Dakin's solution which might be harmful to the bronchus after it opens from 4 to 7 days after operation.

If the lobe is seen to be very dark and swollen an additional ligature of silk or rubber tube, or preferably both should be placed around the hilum so as completely to close the lobar or bronchial artery. A dry gangrenous lobe is small, shrivelled, and not tense. The lobe may be left until it falls away spontaneously in from 10 to 20 days, perhaps even then requiring cutting of the tough bronchus, or the gangrenous lobe may be cut off with scissors several centimeters distal to the hilar ligatures in not less than a week after operation.

After all of the gangrenous stump has been discharged, the granulating wound should be inspected to see if any of the ligatures remain attached and, if so gently removed. The originally air tight drainage tube should be gradually withdrawn.

Until the pleural hole and bronchial opening or openings are completely closed, the hole should be well packed with gauze. This not only prevents pocketing off of pleural abscesses but, very importantly occludes the open bronchi, thereby enabling the patient to expectorate effectively.

The great hole that was occupied by the lobe decreases in size with surprising rapidity owing to compensatory emphysema of the remaining lobe to the progressive rise of the paralyzed diaphragm and to a slight extent to shifting of the mediastinum (Fig. 6). After 2, 3 or 4 months only a saucer-like depression, with one two or three bronchial openings, remains (Fig. 3). As soon as the sputum becomes scanty and no longer purulent, the mouths of the bronchi should be touched with 40 per cent silver nitrate solution every 7 or 10 days. This alone may cause complete closure of the bronchi and epithelialization then soon becomes complete. If however the bronchi resist closure by this treatment and if 3 or more months after operation, the sputum has disappeared and only a little clear mucus is being discharged from the bronchi, the bronchi and the wound can almost always be closed by a plastic operation (Fig. 4). Either a pedicled skin flap or a large latissimus dorsi graft, which is left attached at the antero-inferior rim of the thoracic wall defect, is turned over onto the open bronchi and covered by suturing together the edges of the original cutaneous incision after excision of scar tissue. Pressure is applied by the use of a snug dressing over a rubber bath sponge.

Purulent sputum is likely to persist for several weeks after the second stage operation. Until the hilar bronchus opens several days after operation much of this sputum may come from the diseased lobe itself because its stiff walled bronchus in an infiltrated hilum may have resisted complete occlusion by the hilar ligatures. After this period, some purulent or mucopurulent sputum may persist for several weeks. It probably comes in part from inflammation of the bronchi and trachea that was a complicating part of the bronchiectatic disease and in part from irritation of the exposed bronchial mucosa by the gauze packing. After removal of the diseased bronchi, the bronchial and tracheal mucosa gradually becomes healthy and sputum disappears.

The temperature and pulse are likely to be high for approximately 1 week after the second stage operation the temperature usually being between 101 and 103 degrees and the pulse between 130 and 150, after which they gradually decline to normal though the pulse may remain somewhat elevated for weeks. Sometimes the temperature may become almost normal within 2 or 4 days, and sometimes there may be considerable fever for several weeks.

Owing to the severe reaction of most of the patients to the second stage and to the high fever and debilitating effects of both the disease and the operations, one or more blood transfusions have usually been given after the second operation and occasionally before either operation. Heliotherapy has sometimes been used during convalescence and exercises given to help to prevent scoliosis. This has occurred to an important degree in only 2 patients, in 1 of whom it is severe, but this patient is comfortable and goes to school and does farm chores the other does heavy labor with a circus.

The postoperative defect in the thoracic wall where portions of three ribs have been removed is a relatively small one and cannot fairly be called a "deformity" (Fig 4). Bronchoscopy or a bronchogram (Fig 5) shows the remains of the lower lobe bronchus to be a short cul-de-sac, or a two-horned cul-de-sac if the lobe were resected just distal to the first lobar bronchial division. Good drainage toward the trachea, ciliary action, and the bechic blast probably combine to keep this short stump free of bronchial secretions.

The technique that has been described has been evolved slowly from animal experiments that were begun 11 years ago and from experience with total lobectomy in man which began more than 4 years ago. Many staged cautery lobectomy has already been considered. My first experience with an initial attack upon the hilum was in a patient whose

upper lobe was not adherent and for whom I performed the one stage exteriorization described by Whittemore (36). This patient died 8½ hours after operation with the appearance of shock, part of which I now feel was due to undue traction upon the mediastinal structures by way of the exteriorized lobe. The same technique was used for the next patient. The lobe became only partly gangrenous and the viable remains were destroyed by the actual cautery in several stages. The patient is absolutely well. The next 5 patients were operated on according to suggestions that had been made by Samuel Robinson (23). In 1 of these patients the parietal pleura was merely exposed and the wound closed at the first stage in 3 a gauze pack was placed on the parietal pleura before the wound was closed and in 1 the pleural cavity was opened and gauze placed around the diseased lobe until the second operation was performed 3 days later. The interval between stages in the other patients was 9, 5, 3 and 3 days, respectively. In all 5 patients the lobe was exteriorized at the second stage. In all of these patients, the pleural reaction was relatively unsatisfactory and the undiseased lobe was usually only loosely adherent to the parietal pleura.

The next main phase in the development of the operation was the gentle stroking of the pleura and elongation of the interval between stages to from 9 to 12 days. This has proved very satisfactory and there has been no death among the 6 patients operated upon (between April 1930, and April, 1932) according to this procedure. I shall use in the future such minor modifications of it as have already been considered.

Several other lobectomies have been performed during the period of evolution of the operation just considered but as they illustrate no difference in principle, but only minor modifications to suit particular cases, I shall not discuss them, except to mention the results.

RESULTS

I have personally performed (between January, 1928, and April, 1932) 18 total lobectomies 3 of the patients (16.66 per cent) have died. Only 12 (each with a non adherent undiseased lobe) of these 18 have been operated upon according to principles that have been considered in the body of this article and 2 (16.66 per cent) of these have died (Table I). Six of these 12 have received the benefits of the developed technique and none of them has died.

All of the 12 patients suffered from clinically severe basal bronchiectasis and details of their cases are given in Table I. Four of them are cured

TABLE I.—TOTAL LOBECTOMY IN TWO STAGES FOR LOWER LOBE BRONCHIECTASIS

In all cases undissolved kyle was not adherent before operation

Number	Age at admission	Duration of disease	Malignant				Alveolar			
			Specimen			Complications	Diagnosis	Cough	Cough	Months between lobectomy and the report
			Amount in grams	Color	Character	Smelling or necropsy				
1	16	4 years	20	Field	Purulent			—		26
2	6	7 years	14-15	—	—			Purulent		—
3	8	12 years	12-14		Purulent			—		1
4	8	2 1/2 years	20-22	Field	Purulent	One severe necropsy and others purulent		Purulent and necropsy		1
5	3	7 months	20-22	—	Purulent	Smelling		Non-union of pericardium		15
6	26	4 years	20	Field	Purulent	More than 20 severe necropsies		Abscess ?		—
7	27	4 years	20-22		Purulent	Frequent necropsies 20 to 25 cm.		—		3
8	14	7 years	100-140	Field	Purulent	—		Primary abscess		1
9	20	9 years	20-22	Occasionally field	Purulent			Pneumonia		10
10	9	3 years	100-120	Field	Purulent	Smelling		Severe enough to cause necropsy		9
11	16	9 years	20-22	Field	Purulent	Smelling		Pneumonia		5
12	21	2 years	20-22	Field	Purulent	Smelling		Pneumonia		—

Amount in grams

Color

Character

Smelling or necropsy

Complications

Diagnosis

Cough

Cough

Months between lobectomy and the report

Specimen

Amount in grams

Color

Character

Smelling or necropsy

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Smelling or necropsy

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Smelling or necropsy

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Amount in grams

Color

Character

Smelling or necropsy

Complications

Diagnosis

Cough

Cough

Months between lobectomy and the report

Specimen

TABLE I.—TOTAL LOBECTOMY IN TWO STAGES FOR LOWER LOBE BRONCHIECTASIS (Continued)
In all cases undiseased lobe was not adherent before operation

After lobectomy									
Number	Cough colds hemoptysis	Dyspnea	Complications	Bronchial fistula		No. of wounds in basal pleural	Galls in wt. (lbs.)	Present condition	Remarks
				Open	Closed and wound closed				
				Months after operation	How closed				
1	—	—	Considerable asthma	—	3 1/2	Silver nitrate, later muscle plasty	20	Cured. Doing heavy labor with ease	Lobectomy 4: 30 and 4:11: 30
2	—	—	Chronic bronchitis and asthma	++	—	—	5	Died 14 days after second stage	Average postoperative course and temperature practically normal with no side effects. The apex and terminal bronchopulmonary fistula and terminal bronchopulmonary fistulae
3	Colds	Slight	—	1/2 cm. opening	—	Therapeutic grafts	11	Improved. Household all day	Present condition. Probably from direct tract from apex and from infected pleura. Works 1 hour a day at home and farm work
4	Cough	—	0	—	20	Silver nitrate	13	Classically cured (not on X-rays). Regularly at school	There remains a dry bronchostoma of the upper lobe on basal lobectomy side
5	—	—	Pneumonia, opposite lung. Severe asthma	—	1	Mucous plasty	16	Cured. At school and works in office or does chore on farm after work	Wearing brace for scoliosis
6	—	—	Dyspnea and asthma	++	—	—	1 1/2	Died 48 hours after operation and partially causal attempt to free lobe from firm adhesions	Only moderate drop of blood pressure and rise of pulse first 16 hours. Dyspnea and difficulty in raising operation were prominent
7	Moderate cough	0	Pulmonary tuberculosis	Occasion- ally open about 1/2 cm.	—	Silver nitrate, usually closed	17	Greatly improved	Five months after lobectomy a few early tubercles were seen in non-granular, and tubercle bacilli found at only one examination. Twenty-three months after operation coughed up head of a small gold safety pin
8	Slight cough	0	—	+	14	Spontaneously	10	Greatly improved	Twice pyrexia disappeared after lobectomy. Quiescent and bronchostoma on contralateral fissure. Bronchial fistula reopened 15 months after operation, with asso- ciated moderate hemoptyses
9	Occasional cough	0	—	—	7 1/2	Spontaneously	14 1/2	Greatly improved. Par- tially at liberty as any boy. Regularly at school	There remains a practically dry bronchostoma of the upper lobe on basal lobectomy side
10	0	0	Chronic otitis media, nas- titis, and paranasal	—	3 1/2	Silver nitrate	19	Greatly improved	Chronic infection in ears, sinuses and nasal cavity as does a practically dry bronchostoma of the upper lobe on basal lobectomy side
11	0	0	Acute hemorrhagic pyelitis	—	4 1/2	Silver nitrate	24 1/2	Cured	All symptoms of pyelitis, including abnormal findings in urine and blood, disappeared about five months after lobectomy
12	—	—	Upper lobe tuberculosis, pyelitis	—	—	—	13	Operation too recent for operation as to re- sult. Good prospect for cure	Pyrexia is now small. No signs of pyelitis

(see, however Case 4) 4 are greatly improved and approximate a condition of cure 1 is moderately improved none is unchanged or worse, 2 are dead. One has been operated upon too recently for the result to be judged. By excluding this patient, 9 (81.81 per cent) of the 11 whose results are known are either cured or improved 6 of the 9 have solidly healed wounds without a bronchial fistula and have little or no sputum. Consideration of the 2 deaths in retrospect leads me to believe that 1 of them (Case 2 Table I) was unavoidable and that the other (Case 6) was due to an unwise attempt to free a lobe from tough investing adhesions.

Six other lobectomy patients were operated upon by me (excluding 2 patients, 1 with carcinoma, the other with progressive multiple and already drained abscesses, operated upon with fatal result by other members of my staff) by techniques that are not directly related to the technique that is the subject of this article. The Whittemore operation with the modification of tightly ligating the hilum close to the pericardium before exteriorizing the lobe was used for 2 with 1 operative death and 1 cure. The Everts Graham technique was used in many stages for a total lobectomy in 2 patients with dense pleural adhesions 1 is without symptoms and his bronchial fistulae have been closed with a muscle plasty and the other is slightly improved but has bronchiectasis of the upper lobe which is apparently uninfluenced by a very extensive thoracoplasty. One patient had a gigantic abscess and the other multiple abscesses almost the entire lobe being involved in each case. The abscesses had been drained in both patients before lobectomy which was performed by interpleural isolation of the lobe and ligation of the hilum. One is cured and the other has no sputum but has been operated upon too recently for closure of his bronchial fistulae.

Sixteen of the total 18 patients fulfilled the criteria that I believe necessary for safety in that they either had extensive adhesions over the undiseased lobe or they were caused to form before lobectomy was performed. Two (11.5 per cent) of these 16 died 1 of them after an unwise attempt to separate adhesions before the lobectomy stage itself was undertaken.

Few operations require for a successful result such meticulous attention to pre-operative, operative and postoperative details as does lobectomy.

OTHER METHODS

Almost every imaginable way of performing a lobectomy has been proposed or tried. The important methods have been described in a recent

article by Ballou, Singer and Graham, to which the reader is referred as well as to the original articles of the surgeons whose operations will now be considered. I shall limit myself here to a brief discussion of the principal types of operation.

The most fundamentally important difference of opinion exists today between those who favor one stage and those who favor two or more stage lobectomy. Many of the early lobectomies were performed in one stage. Lilienthal, a pioneer in lobectomy reported in 1925 the largest series of one lobe lobectomies in one stage there were 10 deaths (58.8 per cent) in 17 patients. There were 3 deaths in 5 two stage one lobe lobectomies and at that time Lilienthal preferred the one stage operation but used a two stage operation if the patient's condition was too poor to withstand completion of the operation in one stage. In a personal communication of May 6 1932 to Ballou, Singer and Graham, reporting what is presumably his entire experience with lobectomy for bronchiectasis (42 cases with 27 deaths) (64.3 per cent), Lilienthal announces his preference for a two stage procedure in which he rubs the pleura with gauze dipped in tincture of iodine and, at the second stage, resects the lobe, anchors the ligatures to the thoracic wall, separately ligates the vessels, and closes the chest except for a water seal drain. Sauerbruch (31) in 1927, stated that he had had 6 deaths in 6 one stage lobectomies.

The high mortality figures of one stage operations and also of the two or more stage operations of only a very few years ago resulted in great pessimism about the propriety of employing lobectomy at all and this pessimism is evident in most of the present medical and surgical textbooks. In 1927 however Whittemore reported 5 cases with only 1 death, operated upon by a one stage exteriorization technique that justly aroused interest and hope. This operation has been discussed elsewhere in this article. Brunn, in 1929, reported 6 cases with 1 death, operated upon by a one stage technique that was modeled after that of Lilienthal and of Garré. Shenstone and Jones, operating in one stage, used an instrument with a cord snare that firmly squeezed the hilum without devitalizing it, while the lobe was being amputated and the stump closed carefully in layers, the last layer effecting pleura to-pleura apposition and finally the stump was sutured to the under surface of the upper lobe. These features of the operation caused healing of the stump without bronchial fistula in the majority of cases. With this technique Shenstone and Jones lost only 2 of their first 13 patients and Archibald and Bethune 1 of their first 6.

Judged by the critical standard of mortality percentage the figures given in the preceding paragraphs renewed hope in lobectomy as a reasonably safe operation but the latest available reports of these surgeons are far less encouraging. Whittemore (37) has lost 3 of 10 patients. Brunn (10) 2 of 8. Shenstone and Jones (34) 5 of 16. Archibald (4) and Bethune 2 of 9 and three other thoracic surgeons who I have heard have used the Shenstone technique¹ have lost 2 of 3 patients. The combined figures of these cases, exclusive of the last 3 are 12 deaths (27.9 per cent) in 43 patients.

None of Shenstone's and Jones' patients died from hæmorrhage from the hilar stump, tension pneumothorax, pleural or mediastinal infection, one or the other of which has been responsible for 2 deaths following the Shenstone operation in another clinic and for many deaths after operations performed according to other one stage techniques.

There can be no question but that a one stage lobectomy through an intercostal incision with first intention union of the incision and of the lobar stump and with only a temporary air tight intrathoracic drainage tube has obviously great advantages over any other technique that has been conceived and is a surgical ideal. But if in theory and practice a one stage lobectomy is considerably less safe for the patient than a two stage lobectomy, the ideal must be sacrificed. The best of the one stage figures to date are distinctly inferior to the best of the two or more stage figures.

Theoretically any one stage operation especially in the presence of a non-adherent undiseased lobe seems to me as dangerous as the figures indicate. A one stage operation takes much longer to perform than a two stage operation and for various valid reasons the time factor in a major operation within a wide open pleural cavity upon patients so ill with grave suppurative pulmonary disease as to require a lobectomy probably has considerable bearing upon the occurrence of postoperative pneumonia which has been a prominent cause of death in the one stage reports. I am told that the Shenstone operation takes about 1½ hours though it has been performed in 45 minutes. It appears to me that in the long run pneumonia will not be combated more effectively by occluding the stem bronchus on the diseased side with various balloon devices than by the simpler measures that have been considered in this article.

One of the greatest theoretical as well as actual dangers of any one stage operation is that of infection of the pleura, mediastinum, blood, and thoracic wall. The intrabronchial secretions of

these bronchiectatic lungs are loaded with highly virulent aerobic and anaerobic organisms. When the lobe is resected some contamination of the pleura in the neighborhood of the hilum from the opened bronchus is almost inevitable in spite of careful protective packing. Although obliteration of the entire open pleural cavity which Shenstone's technique tends to accomplish shortly after operation, does much to prevent the development of infection it does occur not rarely. A virulent infection of an unprepared virgin pleura is certainly a grave complication as is progressive infection within the already infected hilar stump which has been closed by suture in layers. This infection may not only quickly reach the mediastinal areolar tissue (Archibald, 4) but it may break down the catgut sutures that were used to close the bronchus and pulmonary vessels and break down the new thrombi with resulting secondary hæmorrhage (Archibald, 4) and bacteriæmia (Archibald, 4). Opening of the bronchus may cause fatal tension pneumothorax if the pleural drainage tube has become occluded by blood (Brunn, 8) or expanded upper lobe. If a patient is given large doses of opiates to help to keep him from coughing open the sutured bronchus the danger of stasis pneumonia is greatly increased.

If the thoracic wall incision becomes infected and breaks open before the mediastinum has had time to become stiffened or the upper lobe to become firmly adherent to the costal pleura the patient is exposed to grave danger of death from mediastinal flutter or its complicating pneumonia. Lilienthal (18) has warned against the danger of anaerobic infection of the thoracic wall incision (whose tissue spaces have not been sealed by a preliminary operation). A further danger of the Shenstone operation is that the temporary snare around the lobar stump may slip before the great pulmonary vessels have been closed by suture, this occurred in one of Archibald's (3) cases but the hæmorrhage was controlled before a dangerous amount of blood had been lost. The increased liability to brain abscess after primary lobar resection has already been discussed.

The evidence that is now available seems to me to dictate the conclusion that the margin of safety is far narrower with a one stage than a two stage operation. Consideration of one stage lobectomy should not be concluded without mention of the delicate and successful technique that Churchill (12) used in removing a carcinoma of the stem bronchus together with two pulmonary lobes and which will shortly be described by him. Churchill (11) prefers a two stage operation preceded by temporary phrenic nerve interruption, for non-

¹Todor Edwards, in recent letter advises us that he has lost only 2 of 10 patients operated on by the Shenstone technique.

malignant pulmonary suppuration if the pleura are non-adherent. He has performed six lobectomies for bronchiectasis without a death, surely a remarkable record. One of his three lobectomy patients for carcinoma is well and two died.

To Samuel Robinson (23-24) should go the honor of being the first to see clearly the important advantages of obtaining adhesions of the undiseased lobe before undertaking the lobectomy itself. It was because his various methods of producing these adhesions just missed being sufficiently effective that lobectomy was not accepted as a useful operation 15 years ago. In his last clinical report he (26) stated that, if it were only possible to get the undiseased lobe anchored and to remain anchored the chief obstacle to successful lobectomy would be removed.

Sauerbruch has apparently been frequently dissatisfied with the techniques he has used and has often changed them. At first (28) he used a one stage operation then (28) a "piece by piece" (stückweise) lobectomy then (28) ligation of the lobar artery and removal of the lobe at a second stage then in 1928 (32) presumably in stages, phrenicectomy, thoracoplasty, ligation of the lobar artery, and if it were possible to free the lobe to the hilum, resection and separate ligation of the artery and vein when feasible but mass ligation when the hilum was especially tough. In weak patients and apparently for others, he advised instead of this procedure removal of a few ribs and an extrapleural pneumolysis with paraffin filling and 6 to 8 weeks later an extensive thoracoplasty with the paraffin in place and 3 to 4 weeks later, removal of the paraffin and of the lobe as the final stage. He also wrote at this same time (1928) of having used an extensive thoracoplasty and later after separating the lobe from adhesions, packing gauze around it and repeating the packing and pressure and, finally tearing the lobe free from its adhesions and ligating its hilum with a rubber tube (Zaaijer 38-39). Nissen, in 1929, writing from the Sauerbruch Clinic, advised using an elastic hilar ligature (Lenhartz) if the hilum were not well fixed in dense scar and if it were, he advised resecting between mass ligatures. Nissen, in 1930 described in some detail the use of paraffin either extrapleurally or intrapleurally when some pleural adhesions already exist, in an effort to produce pleural adhesions as well as to compress the diseased lobe. He advised 2 week intervals between the first and the second and the second and third stages instead of the much longer intervals that Sauerbruch had recommended 2 years before. Nissen at that time proposed surrounding a non-adherent diseased lobe with a cloth bag (Robin-

son in 1917 surrounded it with a gauze pack). The last report from the Sauerbruch Clinic came from Nissen in 1931 emphasizing the importance of having adhesions all the way to the hilum and advising repeated packing before removal of the lobe with an elastic ligature but it is difficult to tell from this article whether or not Sauerbruch has as yet entirely lost his faith in the ability of extrapleural paraffin to form sufficiently extensive pleural adhesions to make lobectomy safe. Denk, in 1929 observed that extrapleural paraffin placed over the diseased lobe as Sauerbruch places it does not cause formation of adequate adhesions over the undiseased lobe, and I do not understand how it could be expected to cause the desired reaction in the mediastinal and hilar pleura.

It appears to me that the Sauerbruch techniques are unnecessarily complicated, that what seem to me as unnecessary major operations (stages) increase the patients jeopardy and that in none of them is any direct effort made to create firm adhesions over the undiseased lobe. These same criticisms apply to the technique employed by Zaaijer and Coryllos. It is not made clear by Sauerbruch, whether or not he has included in his reported statistics any deaths that may have occurred during the thoracoplasty and other stages preliminary to the lobectomy stage proper. If I should not count the death that occurred in Case 6 of Table I after the operation that was performed 10 days before the intended lobectomy my mortality would be 1 death in 11 cases or only 9.1 per cent instead of the 16.6 per cent that I consider the correct figure for the series about which the article is primarily written. I recognize that in a narrow sense a statistical report on "lobectomy" might be considered to include only those patients upon whom lobectomy was actually accomplished, but on the other hand, any death occurring after any stage whatever that the surgeon considers to be a necessary preliminary to the lobectomy itself should properly be counted as a lobectomy death.

The following reports of two or more stage lobectomy (but usually without clear indication as to what techniques were used) have been made from the Sauerbruch Clinic (exclusive of the "piece-by-piece" lobectomies in which there were 2 deaths in 9 patients) 1920 6 lobectomies, 0 deaths 1924 10 lobectomies, 3 deaths 1927 (30) 23 lobectomies, 3 deaths and all the others were cured, not only improved" 1928, 26 lobectomies, 3 deaths 1929 (Krampf) 28 lobectomies, 3 deaths 1931 (Nissen) 38 lobectomies, 4 deaths. These are indeed phenomenal figures and especially startling is the apparent claim that there was but 1 death

in 7 years among 28 patients (compare the 1924 and the 1931 figures just given). Also startling is Sauerbruch's bald 1927 statement that every one of the 20 patients who have survived the operation is actually cured by which should be understood a solidly healed wound without any bronchial fistula whatever and 5 grams or less sputum in 24 hours. When however, Sauerbruch's one stage and piece-by-piece lobectomy cases are added to his two or more stage lobectomy cases there is a total of 53 cases with 12 deaths a mortality rate of 22.6 per cent.

SUMMARY

1 The many dangers inherent in resection of an entire lobe of the lung are expressed in the prohibitive mortality rate of 53.4 per cent for 127 collected cases in which recent improvements in technique were not applied.

2 Another series of 115 cases has been collected from the 8 foreign and native clinics which have contributed most to the study of lobectomy with a mortality rate of 21.5 per cent.

3 In this article are reported 18 personal cases with 3 deaths a mortality rate of 16.6 per cent. None of the last 8 has died.

4 The undiseased lobes of 12 of these 18 patients were not adherent and special measures were taken to overcome this particular danger. Two died (16.6 per cent). Only 6 of these 12 patients have received the benefits of the developed technique and none of them has died.

5 The principles of the operation and its technical details are given.

6 The other modern lobectomy operations are critically considered.

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INTRAVENOUS PYELOGRAPHY

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ONLY a short time has elapsed since the fundamental researches of Roseno von Lichtenberg, Swick, Binz, Lichtwitz, and Hecht first made it possible to obtain adequate radiographic demonstration of the urinary tract by means of an intravenously injected contrast agent. Nevertheless, a large number of important papers have already been published which have led to the rapid development and exploitation of this valuable diagnostic method. Haensch recently gave a comprehensive review of the scope and application of the method at the International Radiological Congress in Paris, and at the same time summarized the history of its discovery. Anyone wishing to obtain a clear outline of the development of the method from unsatisfactory beginnings into a valuable addition to our diagnostic armamentarium should not fail to consult Haensch's article.

It is unnecessary to recapitulate here the steps in the development of the method since Haensch has traced this in its entirety up to and including the introduction of the newest contrast medium for intravenous pyelography, uroselectan B, though the element of time has prevented him from reporting upon any very extensive experiences. In contradistinction to Haensch we incline to the opinion that to a certain extent uroselectan B represents a final stage in the development of intravenous pyelography. Not only has the reduction of the amount of solvent to 20 cubic centimeters greatly simplified the application of the method but in addition the excretion of iodine in the urine has attained a perfectly adequate concentration for contrast purposes and further under ordinary circumstances, it is limited to a short period of time.

Uroselectan B is a pyridin derivative with 51.5 per cent of organically combined iodine. Twenty cubic centimeters contain 15 grams of the substance dissolved in a 10 per cent solution of invert sugar. This amount is sufficient to give clear pictures not only of the urinary tract but also of the renal parenchyma. Although the solution is hypertonic, the addition of invert sugar has, according to our experience, prevented the appearance of such symptoms as a sensation of warmth, thirst, perspiration, nausea or vomiting. We have not observed such effects after the injection of uroselectan B. Occasionally the

patients complain of a drawing pain along the veins in the upper arm radiating into the forearm. These pains are a sign that the injection has been carried out too quickly and can be avoided by injecting more slowly. They are not the precursors of thrombosis, a phenomenon which we have not observed in any case.

Since uroselectan B does not influence the coagulation time or sedimentation rate (von Lichtenberg) there need be no fear of the occurrence of thrombosis or embolism, provided the technique of injection is correct. According to Haensch, uroselectan B may be used in all conditions with the exception of uremia, and our experience confirms this view. Analysis of the urine (Heckenbach) shows that in the first hour following the injection (especially the first 10 to 30 minutes) uroselectan B is excreted almost quantitatively; there is a marked diuresis and the urine shows a high percentage of iodine (about 5 per cent). This property is responsible for the relatively good contrast of the films obtained and for the fact that the ureters are more often filled throughout their whole extent than is the case with other contrast agents. This observation is of particular importance as previously individual authors have considered the demonstration of the ureters in their whole extent as a sign of a pathological condition or irregular function. In spite of all its obvious advantages, we must entirely agree with Haensch's statement that intravenous pyelograms also are upon occasion useless. This is due to the fact that the pictures are relatively weaker in contrast than those obtained with retrograde pyelography. While practice gradually enables the eye to interpret the meaning of the pictures, it sometimes happens that the amount of gas or feces in the gut seriously interferes with the demonstration. Many methods are adopted to avoid this and we have gained the impression that, in ambulant and unprepared patients, this phenomenon is least frequently and less markedly observed. Nevertheless, it is not possible to exclude such an occurrence with absolute certainty and under such circumstances the demonstration of the renal pelvis by means of retrograde pyelography will give better results.

Furthermore retrograde pyelography remains valid not alone for such cases. Flaumer has recently pointed out that the basis of intravenous

pyelography and therefore its indications are entirely different from those of retrograde pyelography. With the latter method we are dealing exclusively with the demonstration of a normal or pathological condition of the lumen of the urinary tract. In this connection, it must not be forgotten that if the contrast agent is instilled at a pressure higher than the normal for the urinary tract, an artificial and deceptive dilatation may take place and an accurate picture of the size of the renal pelvis is not necessarily obtained. The intravenous method while it demonstrates gross changes in the anatomical condition also gives us information as to the size and shape of the renal parenchyma and of its functional activity. This fact enhances the value of the intravenous method from the point of view of diagnosis. From the technical standpoint the intravenous injection of 20 cubic centimeters of uroselectan B is far more agreeable for the patient than ureteric catheterization. It follows, therefore, that the intravenous method with its superior adaptation to physiological conditions, should in most cases precede the application of the retrograde method; the employment of the latter being only necessary when the information given by the former proves insufficient.

In accordance with the observations of Heckenbach on the rate of excretion of uroselectan B the X-ray exposures are best made within a period of 10 to 50 minutes after the injection. In some of our cases excellent pictures of the renal pelvis were obtained 6 minutes after the completion of the injection, this having been carried out with the patient lying on the X-ray table (Fig. 1). Occasionally the most strongly contrasting pictures were obtained by taking a series of films at intervals of 10 minutes up to 90 minutes after the injection. Perlmann refers to the fact that previous investigation of the rate of excretion of indigocarmine may give some indication of the best time for making the exposure. When the kidney function is damaged the excretion of the contrast agent may be delayed on one or both sides and the X-ray investigation may have to be prolonged even into the next day, the exposures being made at longer intervals, before a complete picture is obtained. The pictures gain in definition when the contrast agent is held up in the renal pelvis by means of compression. We were not able to convince ourselves that pressure over the bladder region was of much importance for the success of the pyelogram. It is far more effective to constrict the ureters at the level of the sacrum (Ziegler Koehler etc.) in any case pressure should not be applied until urine containing the



Fig. 1 Taken immediately after injection. Position of right kidney low normal pelvis. On the left renal pelvis is double and two small kidney shadows are seen which in combination give rise to a renal contour somewhat similar to the normal.

contrast agent has collected in the renal pelvis. If the compressor is applied too soon urine containing the contrast agent will become mixed with urine free from it and the contrast in the X-ray plate will suffer. With the use of compression the middle section of the ureter remains unfilled and is not therefore demonstrable. This condition must not be confused with occlusion of the ureter due to stone etc. Further if the renal pelvis appears large there is no reliable method of knowing whether this is due to the stasis produced by the compression or not. For this reason we loosen the compressor as soon as a sufficiently good picture of the renal pelvis for diagnosis has been obtained. In spite of all precautions however it is not always possible to demonstrate the urinary passages in their entirety. Slight changes in the contours of the renal pelvis in particular (small shadowless stones, small tumors tuberculosis etc.) are sometimes better demonstrated by ascending (retrograde) pyelography.

In view of the complexity of the subject and in order to be as concise as possible we would once again refer the reader to Haenisch's paper for a description of various individual points and of the normal appearances. We will confine ourselves here to the discussion of various important points as they arise in the course of describing some especially typical cases.

Figure 1 was obtained immediately after the injection. The left renal pelvis is double. The pelvis can be well seen even to the finest details of the

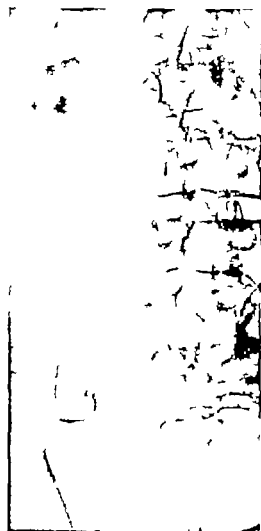


Fig. 2. Forty five minutes after the injection. Con-
centric enlargement of the right renal pelvis which has a
prolongation, similar to the root of a radish, opening into
the ureter. The left kidney shows no excretion and no
shadow of the parenchyma. The bladder is empty.
Diagnosis: left kidney not functioning on account of
destruction of the parenchyma from the hydronephrosis.
Intermittent hydronephrosis of right kidney (see text)

calyces. In the lateral renal pelvis practically only the calyces are filled and the anatomical pelvis shows only a thin contrast shadow. Such pictures often alternate with others in which the same renal pelvis is completely filled and clearly demonstrable. The phenomenon is especially noticeable in small sized renal pelvises, and we attribute it to transient contractions (Mangera, Haenisch). In this case, however another possibility must be considered. The parenchyma corresponding to both renal pelvis is markedly

penetrated by the contrast solution and is, therefore, clearly visible. The parenchyma shows the appearance of a double kidney and both parts are nearly reniform. The lateral portion of the parenchyma is the smaller in relation to the size of the pelvis. The larger portion of the double kidney to which the medially placed pelvis belongs, lies with its most voluminous part corresponding at every point exactly with the position of the anatomical renal pelvis in the lateral section of the kidney. These topographical relationships suggest that possibly the laterally placed renal pelvis is developed only as a narrow fissure and that as a result the thin layer of contrast urine lying in it is not sufficient to demonstrate the pelvis. This possibility must be the more seriously considered since in subsequent exposures no improvement was seen in the demonstration of the renal pelvis. The appearance is not therefore due to transitory contractions but to a permanent condition. Still more the excretion of the contrast urine on this side was practically complete at the end of 30 minutes after the injection. In the pyelogram obtained at this time, "the renal parenchyma showed the normal degree of opacity to X rays, from which it may also be assumed that the excretion of contrast urine on this side has come to an end. For the same reason it is no longer possible in the last exposures to differentiate between the two sections of parenchyma of the double kidney.

To this must be added the fact that even 10 minutes after the completion of the injection the parenchyma and pelvis of the left side show only very weak shadows. On the other hand the parenchyma of the right kidney was unusually clearly visible during the whole time of observation up to the end of 30 minutes, that is to say it was heavily filled with contrast agent. Here too contrast urine was present in the pelvis immediately after the injection. The best degree of filling was obtained 10 minutes after injection but also after 30 minutes the renal pelvis was as easily demonstrable as immediately after the injection. Only after 30 minutes did the pictures gradually become less dense. It cannot be said with certainty whether or not these chronological differences in excretion are due to the obvious congenital malformation of the left kidney. Much greater differences in the excretion time are described by Haenisch in such cases, however pathological changes are undoubtedly present. But in this case also it is particularly worthy of notice that not so much the excretion but the accumulation of the contrast agent in the parenchyma, first sets in on one side long after the



Fig 3. Thirty minutes after injection. Normal pyelogram on left side. On the right side moderate dilatation of the renal pelvis with flattened out calyces. The ureter is slightly dilated as far down as the sacral region. In its neighborhood traces of contrast agent used for the demonstration of an abscess fistula are to be seen. Diagnosis hydronephrosis due to involvement of the ureter in adhesions resulting from a retrocolic abscess due to an attack of appendicitis during pregnancy



Fig 4. Twenty minutes after injection. The right kidney is displaced upward and is somewhat compressed. The neck of the renal pelvis, which is normally directed downward, is turned inward and the ureter filled with contrast urine runs downward along the right border of the vertebral column. While the excretion of contrast urine has passed its maximum point on the left side, on the right side the intensity of the shadow remains the same. One can see "tufts" which are due to filling of the renal tubules with contrast urine, and which appear as continuations of the ends of the calyces. The renal parenchyma is completely intact. Diagnosis retroperitoneal lipoma.

maximum point of excretion has been reached on the other side. Sufficient observations have not as yet been made to enable one to say how far small chronological differences in the penetration of the contrast agent into the parenchyma and its excretion into the renal pelvis are physiological or otherwise. It cannot, therefore, be decided with certainty whether the above described functional condition is pathological. An important point, however is the fact that the accumulation of uroselectan B in the renal parenchyma can take place at different times in the two kidneys. Further it can be clearly shown that unilateral anuria due to prerenal causes does not lead to such a degree of compensatory activity in the other kidney as to permit the latter to excrete the whole of the contrast agent but rather should it be said that the first kidney can later make up for its deficient activity. For this reason the process of excretion must be observed if necessary over a prolonged period.

Figure 2 is a reproduction of one of the pictures obtained from a case in which such considerations

as mentioned were of clinical significance. The pelvis of the right kidney is greatly enlarged and presents flattened contours on all sides. The cusps of the calyces are also enlarged and flattened out. The renal pelvis runs downward sharply and irregularly like the end of a radish, which is strongly suggestive of a constriction of the ureter at this point. The exposure was made 45 minutes after the injection and is in the main similar to its predecessors. The accumulation of the contrast agent in the kidney parenchyma cannot be demonstrated since it is obscured by a collection of gas in the colon. None of the films showed the presence of contrast urine in the bladder. Only after hours of delay was the contrast fluid evacuated from the renal pelvis. This observation definitely shows the presence of an intermittent hydronephrosis. Since the ureters cannot



Fig. 3 30 minutes after injection. Both renal pelvis are filled with contrast urine, the right being lower than the left. The right renal pelvis is much nearer the middle line than normal so that its two lower calyces which are almost vertical lie immediately above the lateral process of the fifth lumbar vertebra. Shadow of the renal parenchyma poor on both sides. Probable diagnosis, horseshoe kidney.

be demonstrated in all cases, this diagnosis can obviously be made only when contrast urine consistently fails to fill the bladder that is to say when the other kidney excretes no urine into it as happened in the case under consideration. We were able to observe this case uninterruptedly for only 9 hours after the injection and 24 hours after the injection we made another control exposure with exactly the same result. At no time in the course of the examination was contrast urine found in the left kidney or ureter.

Such findings can be correctly interpreted only in association with the general history of the disease and the results of other examinations.

A farmer, aged 49 years, complained of attacks of pain in the left upper abdomen and loin for the last 12 years. These have increased in frequency and of late have been accompanied by vomiting and constipation. The corresponding area is tender on examination and palpation.

Intake and excretion of water maintained a balance during a period of a week. The specific gravity of the urine varied from 1018 to 1020. The test for albumin was positive. The sediment showed large numbers of erythrocytes and many leucocytes. No edema was present. The patient excreted 375 cubic centimeters of urine 1 hour after taking 1,000 cubic centimeters of tea and after 2 hours 425 cubic centimeters of a specific gravity of 1003. On a dry diet the specific gravity of a small quantity of urine passed in the evening varied from 107 to 1020. Methylene blue was excreted from the right ureter 5 minutes after injection and from the left in 9 minutes. The urine from the left ureter was only very faintly tinged with blue. Retrograde pyelography was not successful on the left side. On the right side, a pyelogram similar to that shown in Figure 4 was obtained. A review of the individual findings permitted the diagnosis of functional deficiency of the left kidney together with maintenance or perhaps a compensatory increase of the functional activity of the right kidney. At operation the parenchyma of the left kidney was found to be almost completely destroyed. Behind the kidney which was closely adherent to the surrounding structures, was a rigid walled renal pelvis. Its lumen was compressed to a small slit, from the lower lateral pole of which came the ureters. A few drops of cloudy urine could be expressed from it. Dilatation of the pelvic lumen was impossible on account of the rigidity of its walls.

Thus while retrograde pyelography could only show the anatomical changes of the right renal pelvis, intravenous pyelography showed that the kidney had preserved its functional activity. Absence of any contrast agent in the parenchyma of the left kidney justified the conclusion that the power of concentration of the left kidney for the given test substance i.e. uroselectan B (Lichtwitz) was as deficient as for indigo and other dissolved substances. It could also be assumed that the unilateral functional deficiency was responsible for the observed disturbances in the fluid exchange. In this connection it must not be forgotten that there is always the possibility of reversible suppression of function particularly in association with ureteric calculi.

In another case the establishment of the diagnosis was more simple (Fig. 3). In this patient a hydronephrosis had developed as a result of a retrocolic abscess following upon appendicitis during pregnancy, the right ureter having been involved in adhesions. In this case also the intense shadow produced by ascending (retrograde) pyelography is characteristic. Hydronephroses due to mechanical obstruction are excellent cases from the technical standpoint for intravenous (descending) pyelography since they cannot always be filled from below with the same degree of certainty. The question arises as to whether the increased contrast obtained is due to a greater concentration of iodine in the urine or to the fact that the X-rays have to pass through a thicker layer of contrast urine. This can be definitely decided only by estimating the iodine

content of a specimen of urine removed through the ureteric catheter from the intensity of the shadow of the ureters in our film however, it is evident that no appreciable increase in the iodine content of the urine has occurred and that the increased contrast obtained is due rather to the thickness of the hydronephrotic sac and the thickness of the layer of contrast urine contained in it. The ureter is especially dilated in its ilio-lumbar portion. At the point where it passes into the small pelvis the width of its lumen is normal. The seat of the constriction must therefore be searched for in the region of the sacro-iliac joint. This point was also indicated by investigation of the course of the abscess fistula with iodipin (Traces of the iodipin are to be seen as fine flecks of metallic density from the neighborhood of the ilium up to the renal pelvis and ureter). On the opposite side the excretion of uroselectan B is normal.

A characteristic case for intravenous pyelography may be briefly referred to here. In a 23 year old household worker a solid tumor with a smooth upper surface was found filling the whole of the right abdomen. It had gradually grown to its present size and had displaced the ascending colon forward and toward the middle line. As is shown in Figure 4 there was a similar displacement of the right ureter. Other clinical signs contributed nothing to a more definite diagnosis.

After intravenous pyelography had been done the possibility that the tumor was connected with the kidney could be definitely excluded. This opinion was justified not only by the fact that no characteristic changes were found in the renal pelvis but far more because the renal parenchyma was filled with the contrast agent and its contours were on all sides well defined and the mottling such as would have been present in the presence of a tumor was entirely absent. This fact was definitely demonstrable in all the films. Actually the condition was due to a retroperitoneal lipoma weighing 3 pounds. In this case also we observed a difference in the time of excretion of the contrast agent by the two kidneys. Figure 4 was taken 20 minutes after the injection. At this time the excretion of contrast urine on the left side was, as in Case 1 already on the decline. As a measure of this we must consider not only the filling of the renal pelvis with contrast urine but also the intensity of contrast of the parenchyma. In a series of films it is easy to recognize the increase and decrease of intensity which correspond to the functional activity of parenchyma and renal pelvis.

In well contrasting pyelograms such as the present, the urinary tubules are not infrequently



Fig. 5B. Taken in oblique position showing left kidney pelvis. The pelvis and the upper part of the ureter form a curve concave posteriorly. The upper sections are placed more posteriorly than the lower. Probable diagnosis, horseshoe kidney.

demonstrable and give rise to the appearance of 'tufts' which converge upon the ends of the calyces. These tufts are the same as those which as is well known are sometimes found after retrograde (ascending) pyelography. In comparison with the latter however the appearance obtained with intravenous pyelography is less distinct. Individual urinary tubules cannot be distinguished from their neighbors a fact which supports the theory that the urinary tubules can not be demonstrated by retrograde pyelography unless they are distended.

Intravenous pyelography was carried out in a 26 year old farmer who complained of trouble following a kick in the region of the right loin sustained during the previous year. Ureteric catheterization could be carried out only on one side on account of the displacement of the mouths of the ureters. Figures 5A and B which were obtained in this case show that in addition to this anomaly of the ureter the kidneys also had some peculiar features. The right kidney was more than one vertebra lower than normal and was partly displaced medially in front of the vertebral column. The left kidney lay obliquely. In order definitely to exclude the unlikely diagnosis of a floating and dropped kidney an exposure was made in the upright position (vide Röfo) which showed no alteration in the position of the kidney. It should be pointed out in this connection that the taking of pyelograms in the vertical position which is necessary in some cases has been greatly

simplified by intravenous pyelography. With the retrograde method the presence of a cystoscope and ureteric catheters makes this position very unpleasant for the patient unless special arrangements are made.

Unfortunately the parenchyma contained so little of the contrast agent that it was not possible to prove or exclude the presence of a horseshoe kidney which seemed the most likely diagnosis. On the other hand both renal pelves were so well filled with contrast urine that by the combined use of a tube and a lead screen it was possible to obtain oblique views of them one of which is reproduced in Figure 5B. The whole of the left renal pelvis can be clearly seen. The central beam of rays has illuminated the renal pelvis in the same plane as a typical longitudinal hemisection so that all the calyces together with the anatomical pelvis are projected in approximately the same plane.

This appears to circle round the vertebral column in a slight curve resembling a flat spiral. The upper calyces lie more posteriorly the lower more anteriorly the pelvis is displaced in a similar way. The upper part of the ureter continued this curve and then, somewhat lower down it bends fairly sharply backward this peculiar course speaks with some certainty for the presence of a horseshoe kidney.

As a supplement to the numerous earlier works on the same theme these observations and examples will help to determine the limits and possibilities of the new method. It must be pointed out that not all pictures obtained by intravenous pyelography will lead to an exact diagnosis. It can, however be said that the production of uroselectan B constitutes a considerable advance in increasing the reliability of the results.

IRRADIATION IN A CASE OF OSTEOGENIC SARCOMA, RECOVERY

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TO report an isolated example of a pathological condition and the result of its treatment is usually without excuse. If, however the pathological condition should be a malignant bone tumor and the treatment has resulted in cure then such a report becomes not only excusable but desirable. Furthermore if the successful method has been one which has given few or no favorable results previously the case assumes even greater interest. It is proposed to describe the radiation treatment of a case of osteogenic sarcoma and the results obtained. A few general remarks on bone tumors are included.

There is a vast amount of misunderstanding of every aspect of both benign and malignant bone tumors. Much of this is traceable to the lack of a uniform precise terminology as has been stated by others. The variability of development of the mesenchymatous tissues has refined pathological classification out of proportion to the essential basic differences to be found in the new-growths of bone. Causes which cannot be even surmised are operative in the metaplasia of the tissues of the connective tissue group. Bone fibrous and myxomatous tissue cartilage, alone or in combination mature or embryonic in type may compose bone tumors. But, however made up the origin is from the same primitive connective tissue type. If this fact is kept in mind the problem of bone tumors becomes simpler. The natural history of connective tissue and the tumors arising from it only become difficult to understand when too great an ingenuity is used to interpret it.

Contributing to the confused state of knowledge of bone tumors is fortunately their infrequent occurrence. Few physicians except in the larger clinics or hospitals have the opportunity for extended and intensive observation of these tumors. Coley quotes a British estimate of 400 osteogenic sarcomata in England in 1923. Codman is authority for the statement that in Massachusetts (1929) there was one case of bone sarcoma for each 100,000 of population.

The incidence of bone tumors in the group of hospitals allied to the Washington University School of Medicine has been 96 cases in 123,485 admissions in 18 years. The relative incidence of bone sarcoma to sarcoma of other tissues is 24:31. There have been 220 sarcomata of all types 96 of which were skeletal.

In spite of the efforts of the Registry of Bone Sarcoma of the American College of Surgeons and the writings of Bloodgood, Kolodny, Ewing, Geschicter and Copeland and others an astonishing ignorance of malignant bone tumors and their nature persists.

A sharp distinction should be made between tumors that are osseous by virtue of their origin and those that are osseous because of location. The first of these are strictly osteogenic tumors. Osteogenic has been frequently pointed out as an unfortunate term as it is a prolific source of confusion. Its correct meaning designates the origin of bone tumors from osteoblastic tissue. Often however the word is used in a way to imply the generation of bone. As this phenomenon, i.e. the development of new formed bone is encountered in a variety of conditions which are benign some of them even being physiological or normal repair processes it is of minimal diagnostic and prognostic value in the consideration of malignant bone tumors. Moreover in osteogenic sarcoma of the most malignant type new bone formation may be entirely lacking throughout most of the course of the disease. Osteogenic sarcoma is therefore defined as a malignant bone tumor that arises from true bone tissue. They are to be separated from malignant tumors arising from the tissues



Fig. 1. Roentgenogram made February 2, 1922. Antero-posterior view of right knee joint. Lateral view made same date on glass plate which was broken and hence is not shown.

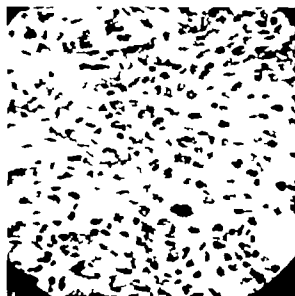


Fig. 2. Photomicrograph of section showing undifferentiated cell type.



Figs. 3 and 4. Photographs of leg made after exploration, March 3, 1932.

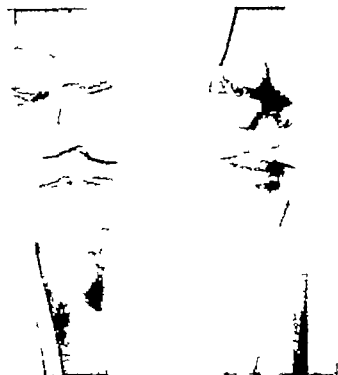
which invest bone or those which are housed in bone. In the former class are subperiosteal fibrosarcoma and capsular sarcoma and in the latter endothelioma of bone (Ewing's tumor) the myelomata, angio-endotheliomata and the epithelial tumors of the jaws of dental origin.

Giant cell tumor should be referred to here but only because it is so often unfortunately designated giant cell sarcoma, this term implying malignant qualities. Indeed, especially when its treatment is being considered, giant cell tumor is often relegated to the same category as the malignant tumors that are found in bone. Thus arises much confusion as to methods and value of treatment. This disease is an independent pathological entity and its relationship to bone tumors is merely a matter of anatomical location.

The treatment of malignant bone tumors is by surgical removal, irradiation and Coley's toxins, either singly or combined. The oldest and most widely employed method of treatment is surgical removal of the tumor by amputation in the case of the extremities, and by excision in the case of tumors of the axial skeleton. The latter is, of course not always possible. At this point the limitations of the application of surgical treatment of osteogenic sarcoma appear.

The objective in the surgical treatment of osteogenic sarcoma is complete removal of the new-growth. Unless all of the tumor is removed recurrence will follow surgical attack. Success is

more apt to follow surgical operation on the extremities than those of the trunk. The weak point in surgical operation is the fact that at the present time there is no way of determining the exact limits of the tumor. Some value in this direction attaches to exploration of the vessels and marrow cavity in the involved member and locating the field of operation at a point where these structures are free from tumor. It should be remembered that sarcomatous extensions follow the paths of least resistance. These are the interior of blood sinuses and vessels, the loose tissues of the marrow cavity and the loose areolar tissue of the fascial planes and intermuscular septa. Since this is written by a radiologist, these points, though well known, are reiterated for the purpose of emphasizing the fact that radiotherapy must be directed to the tissues and areas enumerated to the ultimate limit to which the tumor might possibly extend. The necessity of this is either not understood or is neglected in radiotherapeutic methods. The impossibility of determining the extent of sarcoma is the reason of the failure of both surgical and radiological treatment of this disease. There is an advantage in the toxin treatment of bone sarcoma as compared with either surgery or irradiation. It reaches the ultimate limit of the disease with certitude because the circulation is its vehicle. Determination of the tumor limits for surgical or irradiation treatment is necessarily based on a very crude estimate



Figs. 5 and 6 Roentgenograms of March 10 1932. Anteroposterior and lateral views of the tibia shortly after exploratory operation before irradiation.



Figs. 7 and 8 Roentgenograms of April 13 1932. Anteroposterior and lateral views of tibia at the time deep X ray therapy was instituted.

It has been stated that of the therapeutic methods employed in bone sarcoma surgical removal is the oldest, the most widely used, and has resulted in the greatest number of recoveries. It is a more stabilized form of treatment and there is far greater unanimity of opinion as to the details of its application and the results obtainable than is the case with either the toxin or irradiation treatment of bone tumors.

The toxin treatment has not been as widely used as it deserves to be. One cannot read Coley's reports without drawing two conclusions. First, that in Coley's hands his toxin treatment has yielded more impressive results than can be found in any other method of treatment. Second, it should be more widely, skillfully and faithfully used than seems to be the case except in Coley's hands.

Of the three methods of treatment of osteogenic sarcoma, irradiation is the least understood and the most inconsistent in application and has the greatest diversity of opinions as to methods of use. This vagueness and uncertainty is due to the developmental state of radiotherapy. This is particularly true as regards X radiation. Here there has been constant change of method apparatus, and technique of administration. This has been so diverse that it is impossible for one to evaluate the results of treatment of a few years ago as com-

pared with those of today. Fortunately, this is partly explained by the fact that there has been such great progress in the direction of greater efficiency of this agency. Even with radium there has been great variation in methods and views as to the application of this more stable agent. It may be added that there is no immediate prospect of the complete stabilization or standardization of radiotherapy.

There should be no therapeutic distinction between X irradiation and radium irradiation on the basis of any particular specificity of ray for pathological tissue though many authorities will dispute this statement. The object to be attained in irradiation is absorption of the correct amount of ray by the tumor tissue. This is at times achieved by radium and at others by the X ray. Frequently it is advantageous to employ a combination of the two for example distance irradiation by X ray following interstitial radium irradiation.

It is a deplorable fact that venal consideration sometimes determines the choice of the use of radium or X ray.

Irradiation of osteogenic sarcoma has been chiefly applied to the far advanced cases or as an adjunct to other methods of treatment. In the latter class of cases it is chiefly used for recurrences and metastases. In short, it is applied to unpromising material.



Fig. 9 Roentgenogram of chest made on June 1, 1932.

Ewing is authority for the following "yet some cases of osteogenic sarcoma recover under irradiation." Nevertheless, a review of the literature with this point in mind revealed not a single example of irradiation as the method of treatment in an early authentic example of osteogenic sarcoma.

The subject of this report, the history of which follows, came to treatment relatively early after the onset of the disease. When it presented itself it had the clinical radiological and histological characteristics of osteogenic sarcoma. The type of irradiation employed was first interstitial with radium element followed by application of "deep" X-ray.

CASE REPORT

S. W. Out Patient Department, No. A73030, white girl, aged 11 years, presented herself to the Washington University Dispensary February 2, 1932 complaining of swelling about the right knee. The family and previous history were of no moment. A month before entry patient fell and hurt the region of the right knee which gradually swelled and became painful on its inner aspect. Physical examination revealed only the condition about the right knee. There was a diffuse swelling of the upper medial aspect of the tibia. The knee joint was unaffected. There was slight tenderness to pressure. X-ray examination was made (Fig. 1). The Wassermann was negative. Pain became

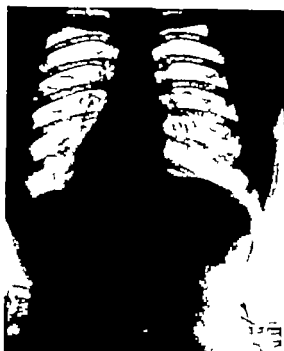


Fig. 10 Roentgenogram of chest made on July 23, 1932.

severe and patient entered the Jewish Hospital, February 5, 1932. At this hospital the tumor of the tibia was explored and found to have the characteristics of malignant bone tumor. In spite of a prior consent, amputation was refused. Material for histological study was removed and it proved to be osteogenic sarcoma (Fig. 2).

The patient was referred to the St. Louis Children's Hospital for irradiation (Figs. 3, 4, 5, and 6). As the tumor had already been traumatized and manipulated by the exploratory operation it seemed that radium implantation could scarcely add to the hazard of mechanical dissemination of tumor cells. It was, therefore, decided to irradiate later internally. Accordingly over a period of 3 days 166 milligram hours of irradiation with radium element in needles was evenly distributed, as well as could be judged, throughout the tumor mass. A week later deep X-ray therapy was applied over both the lateral and medial aspect of the leg to the limit of toleration (Figs. 7 and 8). The patient was irradiated with heavy dosage of X-rays on four occasions from March, 1932, to April, 1932. She has been systematically observed and radiographed from the first observation up to the present time. At no time has there been evidence of pulmonary metastasis (Figs. 9 and 10).

On March 7, 1933 patient was found to be developing a bow leg to such an extent that corrective measures were indicated (Figs. 11 and 12). This deformity appeared to be due to arrested growth of the tibia in the zone which was the site of the tumor. There was arrest of bone growth on the inner half of the tibia, both laterally and from the epiphyseal cartilage. A brace was applied to correct the bowing of the leg.

Routine examination of this patient was made on March 14, 1934. At that time the examination revealed a small collection of faintly calcified material lying medial to the inner tuberosity of the tibia. This increased to the extent noted in the examination of August 19, 1935 (Fig. 13).



Figs. 11 and 12. Roentgenograms of April 24, 1933. Anteroposterior and lateral views of tibia revealing condition of bone slightly more than a year after onset of disease. The bowing of leg is indicated.

Since that time the calcification has remained unchanged (Fig. 14).

Through an entirely fortuitous set of circumstances this patient had what appears to be the unique experience of receiving irradiation treatment for an early osteogenic sarcoma. According to the views of many writers, at least two things were done in this case which are contra indicated, namely, exploration of the tumor without amputation following and intratumoral implantation of radium needles. Under the circumstances as noted the radium implantation appeared harmless.

Biopsy is justified in suspected osteogenic sarcoma, for the diagnosis of this disease is at best a difficult one to make and few physicians have enough experience with it to permit of its early diagnosis on clinical data or even clinical and radiological data combined. Biopsy alone is not necessarily an accurate determinant of the nature of bone tumors. Coley's views on the importance of the gross appearance of these tumors as a factor in diagnosis has not received the endorsement it deserves. If biopsy and exploration is to be done on a suspected osteogenic sarcoma a plan of treatment should be formulated first and be capable of being immediately instituted if desired.

Kolodny has pointed out the fact that intensive irradiation may be highly injurious to surrounding healthy structures. Desjardins has reported a case with marked atrophy of the structures about the shoulder girdle in a case of osteogenic sarcoma (?) of the humerus after intensive irradiation. There

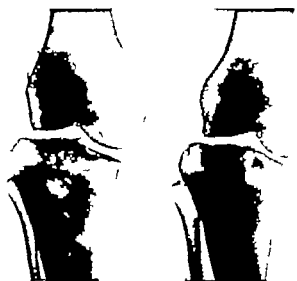


Fig. 13, left. Roentgenogram of August 19, 1931. Calcified material in soft tissue medial to tuberosity of tibia.

Fig. 14. Roentgenogram of July 23, 1932. Shows calcification stationary.

was also sclerosis of the humerus. In the subject of this report there is also marked sclerosis of the tibia. This change, however, seems to have regressed, the affected portions of the tibia assuming the nearly normal striated bone texture of Figure 14. At no time has there been evidence of injury to the knee joint.

CONCLUSIONS

Few conclusions can be drawn from this isolated case. It seems to show that intensive irradiation applied early in the course of osteogenic sarcoma may result in recovery for an extended period (10 years). Tumor exploration and biopsy can be done in this disease without necessarily disseminating it. The same statement applies to intratumoral radium implantation though the writer most emphatically believes that this should not be done unless the circumstances are extraordinary as in this case.

Though irradiation may do great damage to adjacent and overlying healthy tissue, in young persons they can revert to an approximately normal condition and remain so.

It is exceedingly difficult for a radiotherapist always to secure histological diagnosis, hence he is too often working in the dark and is ignorant of just what he is accomplishing. Prolonged observation of patients is next to impossible. Perhaps there are more favorable results in osteogenic sarcoma than is thought to be the case.

The writer wishes to express his appreciation of the kindness of Dr. Malvern B. Clopton for the privilege of observing and reporting this patient. This patient was originally

on Dr. Clopton's service at the St. Louis Children's Hospital.

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PHYSIOLOGICAL REST AND THE PRESERVATION OF LOCOMOTION¹

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THE fundamental and guiding principles of the prevention of deformity and the preservation of function of the apparatus of locomotion should interest both the general practitioner and the specialist. The orthopedic surgeon is primarily concerned in the correction of deformities and the restoration of function of the apparatus of locomotion and, as a teacher, he instructs his students in the underlying mechanical and physiological principles which will prevent deformity and disability. The orthopedist has little opportunity to apply practically these principles as compared with the other members of the medical profession. However he is more cognizant of their meaning and importance since too frequently he sees the crippling conditions which result from a lack of understanding and improper application of them. These principles were not emphasized to the medical student 20 years ago. Today they receive some emphasis and their application prevents many surgical hazards and gives much gratification. The field for their use is large and they are effectively applied as a part of the therapy for any disease or condition which may possibly terminate with partial or complete loss of the functions of the extremities and the spine. Paralyzes, burns, nutritional disorders, bone infections, joint infections, injuries (to nerves, tendons, ligaments, bones, joints, and muscles), the arthritides, congenital deformities and other less common problems may often require the intelligent use of the principles to be considered in this paper.

Collectively the principles may be termed as physiological rest. The principles of rest have been studied and practiced since the time of John Hunter (1728-1793). Sir Arthur Keith states in *Menders of the Maimed* that it was the custom of John Hunter to prescribe rest as a routine measure in the treatment of disablements of the motor system of the human body. John Hilton (1807-1878) regarded rest as the most powerful aid which the surgeon could bring to the aid of disordered tissues and Hugh Owen Thomas (1834-1891) made rest his creed and ritual. Rest as a part of the therapy for disorders of the apparatus of locomotion is at present too often neglected because of insufficient knowledge of its meaning. In general the conception of the term 'physiological rest' is incomplete and confused. The program of physiological rest will vary ac-

cording to the particular disorder but the underlying principles expressed in the following general outline are constant. The principles are mechanical and physiological; the therapy is applied anatomy and physiology.

Physiological rest

1. Surgery (manipulative or open) when indicated.
2. Fixation in the optimum positions—(a) optimum positions when restoration of function is anticipated (b) optimum positions for ankylosis.
3. Maintenance of the integrity of the neuromuscular, vascular and articular systems.

The writer believes that a therapeutic program as outlined will help the physician to understand more clearly the fundamental principles that are important in preserving the functions of locomotion, and it will make for order and clarity in the minds of the medical students as to treatment of diseases affecting locomotion.

Contractures and loss of function of the fingers and shoulder joint following treatment for Colle's fracture are evidence that part 3 of the program outlined was neglected. Extensive scar tissue webs binding the chin to the base of the neck or the arm to the side of the thorax could be avoided if part 2 were properly included in the therapeutic program of treatment for burns. The period of disability and hospitalization of patients with hematogenous osteomyelitis could be reduced if part 1 of the program were adequately executed. A large list of illustrations could be presented to demonstrate that the reason for numerous

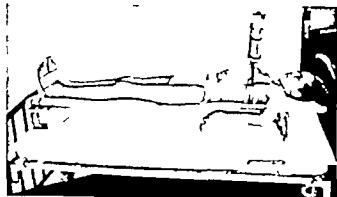


Fig. 1. Patient with extensive paralysis of both lower and right upper extremity during the acute tender paralytic phase of anterior poliomyelitis. The affected extremities are immobilized in the optimum positions for restoration of function. Proper fixation will prevent contracture deformities.

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Fig. 3. A, Residual paralysis of infantile paralysis with multiple preventable contracture deformities of spine, hips, knees, and feet. B, Patient after mechanical and surgical correction of the deformities. Patient had not walked since infancy. The contracture deformities were preventable.

surgical hazards and loss of function of one or more parts of the locomotor apparatus has been negligent application of one or more of the three phases of "physiological rest."

The principles of fixation vary according to whether restoration of function is or is not anticipated. Accordingly there are optimum positions for function when return of function is expected and optimum positions for ankylosis. The positions for fixation of fractures depend upon the type of fracture and the anatomical region fractured. It is not the purpose of this paper to review the numerous positions of fixation for all fractures but to emphasize the need of a clearer conception of the general treatment of fractures by means of physiological rest.

The optimum positions for fixation of the extremities and spine during the acute paralytic stage of infantile paralysis are shown in Table I. These positions are optimum because the lower extremities are in the most useful positions for the function of walking. The pelvis is on a transverse plane and the hips are abducted to favor the gluteal muscular mechanism which plays an important rôle in stabilizing the pelvis during the process of walking. The normal physiological curves of the spine are preserved. The shoulder is abducted and the elbow is flexed for the purpose of favoring those muscles which must function against gravity. The wrist and hand are immobilized in the physiological position of grasp with the thumb in the position of opposition and

TABLE I.—OPTIMUM POSITIONS FOR FIXATION WHEN RETURN OF FUNCTION IS ANTICIPATED (INFANTILE PARALYSIS ACUTE TENDER STAGE)

Shoulder

1. Abduction 90 degrees.
2. External rotation 45 degrees.
3. Anterior flexion (elbow in front of anterior axillary line).

Elbow

1. Flexion 90 degrees.
2. Supination.

Wrist

1. Extension 30 degrees (dorsiflexion).
2. Neutral as to radial and ulnar deviation.

Physiological position of grasp

Hand

1. Fingers in semiflexion.
2. Thumb in position of opposition.

Spine

1. Straight with the normal curves not exaggerated.

Pelvis

1. Transverse plane.

Hip

1. Abduction.
- Neutral as to rotation.
2. Neutral as to flexion and extension.

Knee

1. Straight with support under popliteal concavity.

Foot and Ankle

- Dorsiflexion 90 degrees.
2. Neutral as to inversion and eversion. Arches well supported. Toes side by side and extended.

the fingers semiflexed (Fig. 1). Failure to apply these principles results in the development of contracture deformities which cause partial or complete loss of function of the upper and lower extremities and the trunk, as demonstrated in Figures 3a and b.

Figure 3 demonstrates the principles of splinting for Erb's brachial plexus birth paralysis when return of function is anticipated. Flaccid paralysis resulting from lesions of the peripheral nerves should be immobilized in the position of relaxation as demonstrated in Figures 4a—4b. Relaxation of a partially paralyzed muscle facilitates restoration of function while stretching favors further paralysis.

Burns involving the axillary region should be treated with the arm abducted and externally rotated in order to prevent fixation of the arm to the thorax by scar tissue as seen in Figure 5.

Bowing of the extremities and disturbances of the normal weight bearing lines can be prevented

TABLE II—THE OPTIMUM POSITIONS FOR ANKYLOSIS OF JOINTS

Shoulder

- 1 Abduction.
 - (a) Adult 45-50 degrees.
 - (b) Child 60-75 degrees.
- 2 External rotation—15 degrees.
- 3 Anterior flexion (arm in front of anterior axillary line)

Elbow

- 1 Occupation.
- 2 Right or left handed.
- 3 Flexion 90 degrees with hand in mid pronation. Ankylosis of both elbows—one slightly more and the other slightly less than a right angle.

Wrist

- 1 Dorsiflexion 45 degrees.
- 2 Neutral as to ulnar and radial deviation.

Hand

- 1 Position of grasp altered by occupation.

Spine

- 1 Position in which normal curves are slight. Slight forward flexion of head and neck to accommodate walking and reading

Hip

- 1 Adult.
 - (a) Flexion 45 degrees sitting occupation.
 - (b) Flexion 15-25 degrees standing occupation.
 - (c) Abduction 5-10 degrees.
 - (d) External rotation 5 degrees.
- 2 Child.
 - (a) Flexion 25 degrees.
 - (b) Abduction 5-10 degrees.
 - (c) External rotation 5 degrees.
- 3 Age.
 - Occupation.
 - Degree of shortening

Knee

- 1 Occupation.
 - (a) Straight—standing occupation.
 - (b) Slightly flexed—sitting occupation.
- 2 Child—complete extension.

Foot and ankle

- 1 Plantar flexion 5-10 degrees (altered by sex and shortening of extremity)
- 2 Neutral as to inversion and eversion. Arches supported. Toes extended and side by side.

during the active phase of rickets if the infant is immobilized on a Bradford frame or in a plaster of-paris spica and not permitted to be weight bearing on the softened bones.

Deformity and loss of function of an anatomical part are frequently inevitable. Destruction and loss of function of the affected joint is the usual end result in joint tuberculosis. Gonorrheal arthritis, ankylosing atrophic arthritis, compound intra-articular fractures, and non specific joint infections not infrequently result in fibrous or bony ankylosis. Ankylosis of a joint may greatly



Fig. 3. Brachial plexus birth paralysis is best treated with the affected extremity immobilized in the optimum position for restoration of function as illustrated.

or only slightly interfere with the functions of the apparatus of locomotion. The degree of disability depends upon the position of ankylosis of the affected joint. Loss of function of the hand is minimum and slight if the wrist is ankylosed in the position of dorsiflexion but ankylosis of the wrist in extreme plantar flexion results in very marked loss of function of the hand. Ankylosis of the hip joint in one position may force the patient to walk with the aid of crutches while ankylosis in another position may be associated with only moderate disability. The positions of ankylosis which cause the minimum of interference with the functions of the apparatus of locomotion are known as the optimum positions for ankylosis and may be outlined as in Table II.

Figure 6 represents the proper application of the principles of fixation when ankylosis of the hip is anticipated in a child with infectious arthritis of the hip joint.

The optimum position for ankylosis of certain joints varies according to age, sex, and occupation. The knee during childhood, should not be ankylosed in flexion since with continued weight bearing the flexion deformity increases at the level of the epiphyseal discs. The position for ankylosis of the ankle varies in men and women because of the difference in the height of the heels of the shoes. The adult patient should always be

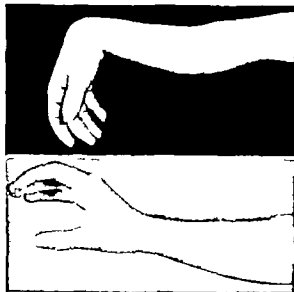


Fig. 4. A, Radial nerve neuritis with wrist drop. B Should be treated with the wrist splinted in the optimum position for relaxation of the paralyzed muscles.

consulted regarding his occupation before the position for ankylosis is definitely determined.

The principles included in part 3 of the program of physiological rest are generally grouped under



Fig. 5. Note the preventable scar tissue web between arm and thorax complicating an extensive burn. Axillary burns should be treated with the arm in the optimum position for return of shoulder joint function (abduction and external rotation)



Fig. 6. The right hip joint immobilized in the optimum position when ankylosis is anticipated. Proper fixation will prevent ankylosis in poor functional position.

the heading of physical therapy. They include numerous measures which favorably influence the physiology of the various tissues which control the functions of the apparatus of locomotion. Assiduous attention to these measures often determines the success or failure of treatment. The integrity of the circulatory neuromuscular and articular systems can be maintained in the presence of certain disorders if mechanical and physiological principles are intelligently applied. These measures may be conveniently outlined as follows:

PHYSICAL THERAPY

- I. The normal stimulus of function
 - A. Weight bearing
 1. Partial
 2. Full
 - B. Active muscular contractions
 1. With joint movements
 2. Without joint movements
 3. Assisted
 4. Unassisted
- II. Elevation
- III. Massage
- IV. Heat—induced fever
 - A. Local
 - B. General—systemic
- V. Cold
- VI. Alternating heat and cold (contrast baths)
- VII. Electrotherapy
- VIII. Heliotherapy
- IX. Occupational therapy
 - A. Under water gymnasium or therapeutic pool

Stiff and useless fingers should never result after proper treatment of a Colles' fracture if the patient is instructed actively and completely to extend and flex the fingers several times daily while the fractured part is splinted. The same patient will not lose the functions of abduction and external rotation of the shoulder on the affected side if the patient is instructed actively and frequently to place the hand to the mouth and back of the head while the Colles' fracture is immobilized. These principles are expressed in a phrase which may be applied to most fractures—“actively mobilize the muscles while the fractured bone is immobilized.”

Muscles of an extremity can be actively contracted although the extremity is firmly immobilized in apparatus. This is often highly desirable in order to maintain muscle tone, to prevent atrophy and muscular contractures and to maintain the integrity of the neuromuscular and articular systems. Several days after surgical treatment for internal derangements of the knee joint the patient is instructed actively to contract the quadriceps muscle. Subsequent knee joint function depends upon the integrity of the extensor apparatus of the knee joint. Many patients who had torn semilunar cartilages treated surgically experienced continued disability because the quadriceps mechanism paralyzed by the local surgical shock, was not re-educated.

The principle of elevation is simple and obvious but the lack of its application is seen daily.

Restoration of function following a supra condylar fracture of the elbow as well as many other fractures is aided by active motions under warm water. The heat stimulates the circulation and the buoyancy of the water relieves much of the weight of the extremity and gravity as a result active motion is accomplished with less muscular effort and with less pain.

A child with residual paralysis of anterior poliomyelitis may be able actively to contract, exercise and develop partially paralyzed muscles under water but out of water the same muscles could not function against gravity and the weight of an extremity. Septic joints, hand infections osteomyelitis, paralyzed fractures and other conditions affecting locomotion will often show remarkable improvement if treated under water at the proper time during the therapeutic program. The number of illustrations to show the practical applications of these various principles is unlimited while the vast number of principles involved in surgical judgment and surgical technique will not even be considered.

The purpose of this paper is not to consider the details of management of any stage of treatment of the many disorders of locomotion but to present a general outline of the program of therapy which will tend to diminish the number of preventable surgical hazards.

The three phases of the program of physiological rest and the numerous principles implied in each should guide the clinical course of all patients suffering with disorders of the apparatus of locomotion.

OVARIAN TERATOMATOUS CYSTS OCCURRING IN CHILDREN

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IT HAS been estimated that of all tumors affecting the ovary 7 per cent consist of dermoid and teratomatous cysts. Such tumors are rarely met with before puberty, although they may occur at any age. McKee, when describing a case in a child aged 7 years which came under his care in 1899, stated that 52 cases only had been previously recorded. Since that time, however, further cases have been recorded but the total number at the present time is still under 100.

At the Hospital for Sick Children Great Ormond Street not a single case has been met with in the last 25 years, either on the clinical side or discovered at autopsy. At King's College Hospital 1 case only (Case 2) has been seen in 25 years and no other case is to be found in the postmortem records. At the Belgrave Hospital for Children, 1 case only (Case 1) has been seen in the last 25 years and no cases have been recorded in the postmortem files.

From the records of these three hospitals, dermoid and teratomatous cysts of the ovary are apparently very rare in young subjects. On account of their relative rarity I have deemed the following cases worthy of publication. Two cases have come under my own personal supervision, while the third case which was under the care of Miss M. Glen Bott, of Nottingham, to whom I am greatly indebted for kindly allowing me the opportunity of publishing it, was of especial interest as it was similar in many respects to one of my own.

Teratomatous cysts are frequently called dermoids, but such a designation is a misnomer and should be discarded. A dermoid is strictly speaking an inclusion cyst, the walls of which contain structures derived from the ectoderm only. The existence of such a cyst in the ovary has yet to be proved.

Teratomatous cysts contain elements derived from the ectoderm, in the form of skin or of its appendages from the mesoderm, represented by unstriped muscle, cartilage and bone and from the entoderm, exemplified by intestinal and respiratory mucous membrane.

The term "embryoma" is frequently used to designate these tumors, and is perhaps a more significant term than "teratoma." Both these

terms, however, are applied to a group of neoplasms composed of heterogeneous tissue elements.

A teratomatous cyst is always composed of two definite parts: (1) an intracystic rudiment in which representatives of all three primitive layers of the blastoderm can be demonstrated; (2) a cyst wall which encloses the embryonal rudiment.

These cysts are occasionally bilateral but are more usually unilateral. The mode of origin of such cysts has given rise to much speculation in the past, but up to the present time no theory concerning their causation is quite convincing. Probably the theory conceived by the late Professor Shattock is the most satisfactory. He suggested that an embryoma may be due to the fertilization of one of the primordial ova in the ovary of the developing embryo, the result being that the embryo gives rise to a second imperfect individual whose origin is not synchronous with itself but is of a later date.

The 3 following cases all occurred in young girls. The cysts were removed by operation, and a careful histological examination was made in each case.

CASE 1. Elizabeth M. aged 9 years, was admitted to the Belgrave Hospital for Children in May 1925 on account of a hard abdominal tumor which had been noticed for some 4 months previously. She was the eldest child of a family of four all girls. Her mother was 32 when she was born, and had been operated upon at the age of 25 for a right ovarian cyst. The child's mother when first she brought her daughter to the hospital, volunteered the remark that she thought her girl had the same trouble as she had had herself and therefore requested that an operation should be performed for its removal. This is the first case of a teratoma of the ovary occurring in both mother and child, which has been put on record.

When first seen at the hospital the girl was found to be an intelligent, well built and athletic child. She stated that she first noticed a lump in her abdomen shortly after Christmas, 1924, when lying in a bath. Previously to that date, she had no idea that there was a lump in her belly and it had caused her no trouble or inconvenience whatever.

On examination, a large hard tumor could be both seen and felt when the patient was lying down. The apparent size of the tumor was comparable to that of a large grapefruit. It was quite smooth and hard and was freely movable in the abdominal cavity. On pressing the tumor in an upward direction the patient complained of some pelvic discomfort. Rectal examination was negative. The growth of pubic hair was extensive, the breasts were well developed and appeared to be about the size of those of a girl at

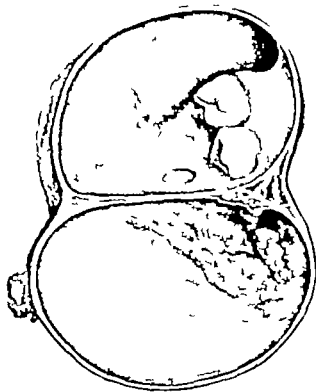


Fig. 1: Drawing of teratomatous cyst of ovary. A section has been made through the center of the tumor (Case 1). The two main cysts are divided by a thick septum. Two large molar teeth can be seen in the upper cyst.

puberty. Menstruation had not commenced. There were no symptoms referable to the alimentary tract. The bowels were open daily without the aid of purgatives. As the girl was in her school net ball team she must have taken a considerable amount of strenuous exercise every week. The kidneys could not be palpated and the urine was normal. There were no symptoms of any pressure on the bladder.

On May 25 the abdomen was opened by a paramedian incision and a large right ovarian tumor was exposed. The tumor had a thick pedicle which was so long that it was quite an easy matter to deliver the tumor outside the abdominal cavity. The pedicle was clamped between two pressure forceps and the tumor removed. The pedicle was transfused and the cut end was so carefully sewn over that no raw surface was left exposed. The uterus and other appendages appeared quite normal. The whole abdominal cavity was explored but no other abnormality could be discovered. The wound was closed in layers with interrupted sutures. The patient made a rapid recovery and was able to leave hospital 16 days after the operation.

She was brought up to hospital again in July, 1935, as she had had a period which lasted 4 days, but otherwise appeared normal in every respect. She remained under observation for some long time. She kept quite fit and well and although she was not yet 10 years of age, her periods occurred regularly. Whether the removal of the ovarian teratoma had an influence on the early menstrual history of this patient or not, is a moot question.

The tumor measured 4 inches across, and weighed just over a pound. It was hardened in formal solution and some 10 days later was subdivided by a median section.



Fig. 2: Microscopical drawing ($\times 25$) of the wall of the cyst in Case 1. The edge of the cyst is partially covered with thick stratified epithelium showing keratinization. The section exhibits two gland ducts, lined by high columnar epithelium and areas of dense leucocyte infiltration.

It was found to consist of two cysts, an upper and a lower (Fig. 1). The walls of the cysts were very thick and fibrous. Inside the upper cyst was a solid elevation on the summit of which two well marked molar teeth could be seen. The lower cyst contained thick mucoid fluid and on the inside, at one place, there was an irregular thickening which on section was found to be cartilaginous. No hair was found in any part of the tumor.

Microscopically the tumor exhibited the characteristics of a teratoma. The lining of the cyst was in places columnar ciliated epithelium in others it was composed of stratified epithelium (Fig. 2). Sebaceous glands and also some nervous tissue could be seen. In other sections distinct areas of cartilage were found but in no part was there any evidence of bone. In all probability bone would have been found in the region of the molar teeth, but as the specimen was preserved intact, as far as possible, micro-

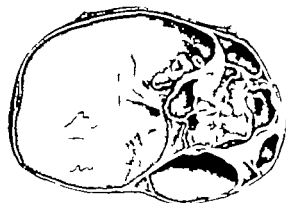


Fig. 3. Drawing showing one-half of ovarian teratoma removed in Case 5. Multiple cysts can be seen.

scopical sections were confined to the region of the cyst wall only.

CASE 5. Elsie B. aged 8 years, was quite healthy up to the age of 5 years, when she commenced to suffer from constipation and required purgatives three times a week at least. She was treated for constipation at several hospitals and dispensaries but her condition did not improve.

Apart from the constipation, she enjoyed good health, and was quite a bright and intelligent child. On November 30, 1931 she was seized with abdominal pain and vomited several times. The vomiting was followed by some loose motions. The pain lasted a few hours only. Shortly after ward she was playing with other children and appeared to be quite normal. The mother gave her a bath in the evening and then noticed a swelling in her abdomen, which she was quite certain had not been there before. The child was sent up to King's College Hospital where she was found to have a large, hard abdominal tumor about the size of a small coconut. It was movable from side to side, and slightly from above downward, but could not be displaced upward farther than the bend of the pelvis. The tumor appeared to be cystic in places. Since the appearance of the tumor the child's bowels had acted normally every day without the aid of any purgatives. Rectal examination was negative.

The girl was shown at a meeting of the Children's Section of the Royal Society of Medicine, on the 17th of November 1931, as a case of dermoid cyst of the ovary. The consensus of opinion, however was that the tumor was a mesenteric cyst.

The history of this case is all important since I came to the conclusion that the cyst had been within the pelvic cavity for several years, and was there the cause of the habitual constipation. When it suddenly rose out of the pelvis, as it undoubtedly did, it brought about a certain amount of shock which caused the child to vomit. If the tumor had slowly developed within the abdominal cavity proper the child's mother who bathed her every night, would certainly have noticed a swelling before. The subsequent relief of the constipation due to the diminution of pressure within the pelvic cavity is especially worthy of note.

On December 2, 1931 a laparotomy was performed under open ether anesthesia. The abdomen was opened through a right paramedian incision, and a large right ovarian cyst, weighing just over 2 pounds, was removed. The left ovary was normal. No other abnormalities within



Fig. 4. Microscopical drawings of different parts of the wall of the tumor in Case 5 above, microscopical drawing showing dilated capillaries in dense fibrous tissue. Below, microscopical drawing showing thin layer of stratified epithelium opening on the surface of which is a sebaceous gland. Four hair follicles lying more deeply in the section can be seen. (X75)

the abdominal cavity could be found. The wound healed normally and the child was able to leave hospital 14 days after the operation.

When the tumor was cut through its center was found to be mainly cystic with a hard solid formation at one part (Fig. 3). Microscopical examination of the wall of the cyst demonstrated its teratomatous nature. A number of cysts of varying sizes could be seen. One of the larger cysts was lined partly by columnar ciliated epithelium, and partly by a thick layer of stratified epithelium which, however did not show much tendency to the production of keratin. Sebaceous glands in association with this stratified epithelium were present (Fig. 4). Some of the cysts had lost their epithelial lining, but some, especially the smaller ones, were lined by columnar or cubical epithelium. Some of the cysts contained a homogeneous pink-staining material resembling thyroid colloid, otherwise no definitely recognizable thyroid tissue was present. There was ample evidence

of nervous tissue and several areas of calcification were found. The solid portion within the cystic cavity was found to contain hair, cartilage, and bone.

A very similar case to the foregoing was recorded by Meigs in 1899 in a girl aged 10 years. An abdominal swelling was noticed by the child's mother when she was undressing her. When the girl was examined at the hospital the swelling was thought to be a distended bladder. Catheterization was performed but a few ounces only of urine were withdrawn. Operation was performed and a twisted ovarian teratoma which contained sebaceous material, cartilage and bone was removed.

A correct diagnosis of these cases seems to be one of supreme difficulty and almost every variety of abdominal tumor has, at one time or another, been suspected without the real condition having been recognized.

CASE 3. Agnes W. aged 9 years, was admitted to the Children's Hospital, Nottingham, on the 31st of October, 1931 under the care of Miss M. Glen Bott, complaining of attacks of abdominal pain. The symptoms commenced insidiously in March, 1931. She complained of pain which had no relation to food but was accentuated by walking. The seat of the pain was situated just above the pubis. It was not relieved at night time, and she suffered from frequency of micturition. The bowels acted normally and there was no history of vomiting.

On admission to hospital, the patient was found to be a well developed and healthy looking girl. A pear-shaped swelling could easily be palpated in the abdomen. It was movable from side to side, and slightly upward and downward. It was dull on percussion, but not tender. Rectal examination was negative.

An operation was performed through a subumbilical paramedian incision. A large right ovarian cyst was removed, measuring $4\frac{1}{2}$ by 5 inches. The left ovary was slightly larger than normal. The abdomen was closed in layers, and the patient made an uninterrupted recovery and was discharged from hospital on November 11, 1931.

The cyst was unilocular with a smooth wall. Situated near the base of the cyst was a definite, hard, intracystic elevation covered with stratified epithelium. Beneath the stratified epithelium, a single tooth was found to be embedded in a matrix of bone and cartilage. There was a considerable amount of hair and sebaceous material which provided an embedding medium in which all the tissues were glued together in a mass.

McKee recorded a case in 1900 in a girl, aged 7 years, where an abdominal tumor was thought to be a sarcoma of the kidney. Operation proved it to be a cystic swelling of the ovary containing

skin, sebaceous material, cartilage, and bone. In some of the early cases which are recorded tapping of these swellings was carried out in some cases because operative interference was not permitted by the parents of the child. Alcock in 1871 and Black in 1892 record cases where tapping was performed followed at a later date by removal of the tumor.

Owing to the systematic medical examination to which school children are now subjected it is very unlikely that ovarian cysts in young subjects will in the future, be allowed to assume any large size.

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LATERAL ABERRANT THYROID GLANDS

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TUMORS of the neck arising from lateral aberrant thyroid glands are rare and I have been able to find but 49 cases in the literature. The group as a whole has long been recognized. Albert von Haller in 1779 first observed anomalously placed islands of thyroid tissue in the neck. In 1839 Albers referred to misplaced thyroid tissue as accessory thyroid glands. Gruber in 1845 reported 2 cases and in 1849 a monograph accurately describing accessory thyroids, was published from Milan. In 1850, Stanley of England made the first extirpation of an aberrant thyroid gland. Occasional reports of clinical cases appeared up to 1897 when de Boncourt collected 15 cases of accessory lingual thyroids. A few years later Storm, Murphy and Schragar made extensive clinical studies.

The importance of lateral aberrant thyroid glands demands the interest of the embryologist and pathologist as well as the clinician. Embryologically their origin and development is much discussed but far from settled. Pathologically they are greatly influenced by the activities of the thyroid gland. They also show a distinct tendency to malignancy. Clinically their diagnosis is difficult and their prognosis favorable.

ORIGIN

Several theories have been advanced to explain the formation of lateral aberrant glands, these changing from time to time as additional information has been brought to light on thyroid embryology. It was once thought (Hls, Born, Prenant and others, that the thyroid originated from two sources, namely a median portion from the floor of the pharynx and two lateral portions from the lateral outpocketings of the pharynx. At that time it was possible to explain the presence of lateral thyroid tissue by assuming fusion of the lateral and median portions of the gland had failed to take place and as a result lateral rests remained in the neck.

Later following the discovery of the origin of the parathyroid glands from the third and fourth branchial clefts it was thought that the thyroid originated entirely from a single median anlage caudal to the anterior portion of the rudimentary tongue and that fusion played no rôle in its development. This theory necessarily discounted the belief that lateral rests were due to unfused thy-

roid tissue. More recently the so called fifth pouch, or ultimobranchial body has been claimed to play a part in thyroid development but upon this subject embryologists give decidedly conflicting opinions.

With the embryology of the thyroid still unsettled the origin of lateral aberrant thyroid glands likewise remains disputed. At present, evidence points strongly toward the origin of the lateral aberrant thyroid from the fifth pouch or ultimobranchial body. This theory is supported by Leech and his co-workers as follows: "The thyroid in its development is constantly associated with the migration and fusion of epithelial cells derived from the so called fifth pouch or posterior outpocketing of the pharyngeal complex (the ultimobranchial body) these epithelial masses may vary considerably in number and position the lateral aberrant thyroid glands tend in a high percentage of cases to undergo papilliferous and cystic degenerative change, a lesion never associated with lingual thyroid tissue. These facts, it would seem, serve to identify these tumors as a specific group and to account for their origin on sound embryonic evidence."

SYMPTOMS AND DIAGNOSIS

Many lateral aberrant thyroids produce no symptoms. As they increase in size they may cause the patient to consult a physician on account of swelling in the neck. Few produce sufficient pressure on the trachea and vessels of the neck to cause symptoms. Their growth is slow over a period ranging from several months to several years without signs of thyroid disease. They are usually situated in the anterior triangle of the neck and may occur as single tumors or as a chain of nodules. On palpation they are not tender and may be firm or soft in consistency. There are no constant clinical characteristics to differentiate lateral aberrant thyroid glands from tuberculosis, lymphadenoma, metastatic carcinoma, Hodgkin's disease or other conditions which may give rise to tumors of the neck consequently diagnosis is extremely difficult and rarely made. As an aid in differentiating these tumors of the lateral aberrant thyroid glands from other enlargements of the neck, Schragar has emphasized the following: (1) The tumor is likely to increase in size at puberty (2) It tends to fluctuate in size

during menstruation (3) It tends to become cystic. (4) It is usually unilateral if solid not greater than the size of a mandarin orange. (5) It is of slow growth, smooth and if not cystic of soft consistency.

PATHOLOGY

Briefly, lateral aberrant thyroid glands may be single or consist of a chain of glands connected by strands of thyroid tissue. In size they may vary from a few to 10 or more centimeters in diameter. They are encapsulated in a very vascular reddish green capsule and are firm or soft depending upon the amount of cyst formation which has taken place. Often they resemble normal thyroid tissue. Microscopic sections show a marked papillary growth of columnar epithelial cells in a vascular connective tissue stroma with evidence of slow growth as manifest by calcification, hemorrhage, hyalinization of stroma and cystic degeneration. The tendency of these tumors to undergo malignant degeneration is great and it is not uncommon to find mitotic figures and other signs of malignancy in what may otherwise appear to be a benign tumor.

During the past 10 years 3 cases of tumors of aberrant thyroids have been observed in the Presbyterian Hospital. These patients have been followed for 10, 9 and 7 years respectively. One of the patients subsequently developed marked hyperthyroidism from which she made a good recovery after subtotal thyroidectomy. Another writes that she is in excellent health and has had no illness since her operation. The third cannot be located at the present time. He was in good health for 7 years after his operation.

REPORT OF CASES

CASE 1: I. J., a woman aged 30 years, entered Presbyterian Hospital complaining of a tumor of the left side of the neck which had been present for several years gradually increasing in size during this time but with a more rapid increase during the past 6 months. She had no other subjective symptoms, the tumor had caused her no pain, and she stated that her general health had always been good. During childhood she had had measles and chickenpox and at age 17 years, an appendectomy. Her father, mother, two sisters, and a brother were living and well and no history of tuberculosis, malignancy or thyroid disease in the family was known.

The patient was a well developed, well nourished woman with a tumor mass behind the angle of the left jaw about the size of a hen's egg. On palpation the tumor mass was found to be medial to the upper portion of the sternomastoid muscle. It was firm, freely movable, showed no redness, and was not tender. The thyroid gland was palpated in its normal position. The teeth were good, the tonsils showed no infection, the heart borders were normal. There was an appendectomy scar in the right lower quadrant of the abdomen. Reflexes normal.

The urine was normal, the hemoglobin, red, white and differential blood counts were normal. X ray picture of the



Fig. 1. I. J. Showing extensive growth of cuboidal epithelial cells arranged in papillae and alveoli.

chest showed a small, old, healed tuberculous process of the left apex.

Under local anesthesia, an incision was made in a vertical direction through the skin and fascia. The tumor mass was exposed and carefully dissected out.

The specimen consisted of a mass measuring 4 by 3 by 2 centimeters. It was red and rather firm. The surfaces made by sectioning were moist, reddish brown, and in portions resembled normal thyroid tissue while in other areas the tissue was soft and friable and contained small cysts. Microscopic sections showed extensive growth of cuboidal epithelial cells arranged in papillae and alveoli. The connective tissue was slight in amount. There were several fairly typical acini seen (Fig. 1).

CASE 2: G. P. E., a man aged 32, entered Presbyterian Hospital complaining of a swelling in the left side of the neck of 7 years' duration, which had been gradually increasing in size during these years but had caused him no pain or discomfort in any way. During the past 2 months he noticed the increase in size of the tumor more than previously. During childhood he had had measles and mumps and an occasional sore throat. His father and mother were living and well. There was no history of tuberculosis, carcinoma or thyroid disease in the family.

The patient was well developed and well nourished. A firm, movable tumor about the size of a plum was found on the left side of the neck posterior to the angle of the jaw. Below this was a second tumor of the same description about the size of a hazel nut and along the anterior border of the sternomastoid muscle about 2.5 centimeters above the clavicle was a third tumor the size of a small plum and of similar consistency. The thyroid gland was palpated in the normal position. The tonsils were absent, teeth good, heart borders normal. A slight systolic murmur was heard over the apex. Pulse was regular, rate 72. Blood pressure was 102 systolic, 70 diastolic. The lungs were normal. No tenderness or masses were noted in the abdomen. The reflexes were normal.

The urine was normal, the hemoglobin, red, white, and differential blood counts were normal. Blood Wassermann



Fig. 2 G. P. E. Showing papillary growth of cuboidal epithelial cells which in certain areas suggest malignancy.



Fig. 3 M. B. Showing marked growth of cuboidal epithelial cells in papillary and cystic formation.

was negative. X-ray examination of the chest showed a slight increase in hilar shadows but otherwise was negative.

Under ether anesthesia, an incision was made along the anterior border of the left sternomastoid muscle and seven glands were removed from beneath the muscle in its course through the neck.

The specimen consisted of seven nodes of various sizes, the largest being 5 centimeters in diameter. They were red and firm. Surfaces made by sectioning were moist, reddish brown, and contained a few small cysts in which there was a brown fluid. Microscopic sections showed marked papillary growth of cuboidal epithelial cells growing on a markedly vascular connective tissue stroma. In the base of some papillae were found groups of apparently normal acini lined with cuboidal epithelial cells and filled with colloid. The papillary structure in certain areas suggested malignancy (Fig. 2).

CASE 3. M. B. a woman, aged 36 years, entered Presbyterian Hospital complaining of a swelling in the left side of the neck present for 15 years or possibly longer. This swelling was first noticed during puberty and seemed to be slightly larger during her menstrual periods. Aside from this slight fluctuation the mass had not changed in size to any noticeable extent. She had reduced 35 pounds by dieting 3 years previous to her admission to the hospital. Since that time the swelling had been noticed by her friends and she had been quite conscious of it. She thought at times she had a slight choking sensation due to pressure of the tumor. Her general health had always been good. She had had chickenpox during childhood and an attack of influenza 6 years previously. A dilatation and curettage had been done following a miscarriage. There was no history of other pregnancies. Patient's husband had died of malaria. Her father, mother, one brother and two sisters were living and well and there was no history of tuberculosis, carcinoma, or thyroid disease in the family.

The patient was a well developed, well nourished woman with a tumor mass about 2.5 centimeters in diameter on the left side of the neck anterior to the middle third of the sternomastoid muscle and a second tumor slightly smaller

at the angle of the jaw. On palpation these tumors were slightly soft, freely movable and not tender. Apparently there was no pressure being exerted by these on the trachea. The thyroid gland was palpated in the normal position.

The tonsils were not infected. The heart borders were normal, no murmurs were heard. Blood pressure was 120 systolic, 85 diastolic. The pulse was regular rate 84. The lungs were normal. No masses or tenderness were noted in the abdomen. The reflexes were normal.

The urine was normal, the hemoglobin, and the red, white and differential blood counts were normal. Blood Wassermann was negative.

Under local anesthesia, an incision was made along the left sternomastoid muscle and the two tumor masses were removed by careful dissection.

The specimen consisted of two masses, each measuring approximately 4 centimeters in widest diameter. The tissue was red brown and firm for the most part, having a few small soft areas. The surfaces made by sectioning were moist and red brown. In the soft areas considerable brown fluid and small cysts existed. Microscopic sections showed marked cuboidal epithelial growth in papillary and cystic formation. The connective tissue was considerably increased and vascular (Fig. 3).

TREATMENT

In any case of suspected aberrant thyroid, the presence of a thyroid gland in its normal position should be determined. Once this has been established all doubtful masses in the neck should be removed. It is well to remember that pathology in the thyroid gland proper may cause enlargement with changes of the associated aberrant gland and in these cases it is well to proceed with considerable care. The location of these glands makes injury to the spinal accessory nerve and jugular vein easy. Another common complica-

tion is profuse bleeding. Because of the cystic structure of these glands aspiration has been attempted but this should not be done for it is both useless and not without danger. Following surgical removal all patients should be subjected to a series of X ray treatments such as are given for malignancy even though the tumor appears to be benign. These postoperative X ray treatments are of great importance as these tumors are radiosensitive.

SUMMARY

The tendency of lateral aberrant thyroid glands to undergo malignant degeneration has already been called to attention repeatedly but so important is this fact that it cannot be overemphasized. Although to all appearance these glands may be benign they have been known to recur after removal and produce metastases. That generally accepted benign tumors of the thyroid such as enchondromata and myxomata may become malignant is well known and years ago Cohnheim called attention to metastases arising from adenoma gelatinosum of the thyroid a benign tumor. Hinterstoisser in an extensive study of carcinoma of aberrant thyroid tissue observed that carcinoma of aberrant glands is less malignant than carcinoma of the thyroid gland proper. Recently Leech and others after a careful study of malignant tumors of the thyroid have pointed out the similarity between papilliferous adenomata of the thyroid and tumors of lateral aberrant thyroid tissue suggesting the possibility of a single origin for both groups of tumors from pharyngeal epithelial rests of the fifth pouch.

CONCLUSIONS

1 Lateral aberrant thyroid glands are extremely rare. They are of great clinical as well as of embryological and pathological importance. They are difficult to diagnose and tend to become malignant but with good surgical therapy they offer a relatively good prognosis.

2 In the presence of a thyroid gland in its normal position, suspected masses in the neck should be removed. X ray treatment should be given following removal in all cases.

3 Three additional cases of lateral aberrant thyroid glands are presented.

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RICHTER'S HERNIA

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RICHTER'S hernia is a rare unusual type of hernia. In spite of its rarity, an understanding of its pathology and the symptoms associated with it is important since any delay in recognition may result in very serious consequences. While Richter's hernia is a form of strangulated hernia, it is characteristically associated with partial intestinal obstruction rather than with complete obstruction which is usually present in strangulated hernia. Richter's hernia may be described as a hernia in which only a part of the circumference of the bowel is engaged and strangulated and this involved portion may rapidly become gangrenous although the lumen of the gut remains open to some degree. The portion of the engaged bowel resembles a small diverticulum of the wall (Fig. 1). Only those hernias that meet the description given should be included under this name.

In the early literature there was much confusion concerning this type of hernia, since many types were reported under this name, for instance, cases of small hernia, partial enterocele, incomplete hernia, pinching hernia, Littre's hernia, and the like have been reported as Richter's hernia. After an exhaustive review of the early literature Treves found 80 cases, in 53 of which the reports were complete enough for satisfactory identification and study. He included 4 operative cases of his own and gave a clear clinical picture of this condition. Three of his patients died after operation while the fourth, in whom previous to operation a reduction of the hernia had been done *en masse* recovered following operation.

In 1700 Littre described 3 cases in which only a portion of the bowel wall was found in the hernia sac; 2 of these were hernias later recognized as involving Meckel's diverticulum but the third could not be identified from his report. He believed that these diverticula were the result of the intestinal wall being pulled out into a sac. It was not until 1815 that Meckel described the diverticulum that now bears his name, thus explaining the true nature of Littre's 2 cases. The first complete scientific description of this type of hernia was made by Richter in 1778. He described this form of hernia as a small rupture.¹ In his book on hernia, one chapter concerned the diagnosis and

treatment. He recognized that the wall of the involved gut was made up of the same layers and structure as were present in the intestinal wall, a condition not present in the diverticulum later described by Meckel. In considering treatment, he recommended, if gangrene had not appeared, reduction aided by dilatation of the ring with a hook, but if gangrene was present he believed that reduction was dangerous and that resection should then be done. Treves suggested that this type of hernia be called Richter's hernia in order definitely to identify it and to differentiate it from the hernia of Littre and other forms. The earliest report Treves was able to find was that of Guilielmus Fabricius Hildanus in 1606.² In the fifty-fifth observation of his first one hundred surgical cures, he described the case of an elderly woman who had a strangulated hernia which discharged into the groin, after which the patient had complete relief of symptoms. The intestinal fistula thus formed remained open for only 2 months following the scarification of the swelling; it then healed and the patient made a complete recovery. While the exact relation of the bowel to the hernia was not observed, the fact that the fistula closed indicated that only a portion of the bowel wall was in the hernia.

In 1809 R. S. Fowler reported under the title "Partial Enterocele" 2 cases with this condition. He again made an exhaustive review of the literature and included a full bibliography in chronological order including 94 references. He presented an excellent clinical picture of the condition which was similar to that presented by Treves. R. H. Fowler in 1913 described 3 cases, one involving the cecum and the other the appendix. A review of the literature after 1809 was made by Rhodes in 1928. He was able to find 45 additional references since Fowler's report in 1809 and reported the histories of 3 patients with true Richter's hernias and 3 patients with a knuckle of small intestine in ventral hernias. The confusion which was present in the early literature was again evident in Rhodes' report since many of the reports that he included were of Littre's hernia. Bissell reported 2 additional cases in 1929, while Orr added 1 in 1930. After a review of the old and new literature on this subject, it will be seen that little attention has been

¹This book was obtained from the Library of the New York Academy of Medicine.

²This book was obtained from the Boston Medical Library.

paid to it since 1899 few reports were found, only 14 operations for this condition being reported. This by no means represents the actual incidence or number of patients seen and treated. So little attention has been given the subject that undoubtedly many patients are treated for simple strangulated hernia. Many of the standard text books in surgery do not mention the subject but we believe it is sufficiently important to report the cases seen.

CASE 1. An American laborer 60 years of age was examined in March 1927. He had been well until 24 hours previous to this examination when he developed a pain in the left lower quadrant. On the day that he was seen he had vomited several times. He had not been aware that he had a hernia. On physical examination he appeared to be acutely ill. His tongue was clean and there was no fecal odor to his breath. The abdomen was soft throughout, there was no visible peristalsis and no distention. A small swelling about 2 centimeters in diameter in the left groin could not be reduced. There was localized tenderness over the swelling. Operation was performed (Dr. H. M. Clute) 24 hours after onset, incision being made directly over the femoral ring. When the sac was opened, a segment of bowel was seen engaged in the ring (Fig. 2). The sac was purplish blue in color. The nature of the hernia was recognized as of the Richter type. The first incision was left open, the abdomen was opened with a left rectus incision, and the gut was reduced following enlargement of the hernia neck. The circulation appeared to return to this small involved portion although a small constriction ring remained. The area was then inverted without interfering with the lumen and the abdomen was closed in layers. The hernia was repaired in the usual anatomical fashion. This patient made an uneventful recovery and is now well, 5 years after operation.

CASE 2. An American farmer 63 years of age was seen in October 1930. He stated that several days previous to the examination his bowels had been constipated. A cathartic had not given any results. Two days before he developed a colic-like pain in the epigastrium which was localized just above the umbilicus. This pain was so severe at that time that one-quarter grain of morphine was given. He vomited once on this day. The following day the pain, still localized in the same area, recurred with about the same severity and again morphine was given. The patient was given an enema with fair result as to the elimination of gas, but it gave him considerable pain. Nausea persisted but there was no further vomiting. No blood or mucus had discharged from the rectum. Six years previously patient had had an abscess in the right groin which was incised. There had been no recurrence of infection in this area and no swelling had been noticed.

On physical examination patient appeared to be strong, well developed, but to have lost considerable weight. His tongue was dry and clean and his breath was not fecal. On abdominal examination there was found a moderate general distention but no spasm and no masses. A fluid wave could be demonstrated. There was no visible peristalsis. A small mass about 1 inch in diameter was present in the right femoral region. No impulse was obtained when the patient coughed. No attempt was made to reduce the mass, which was not tender on pressure. A healed scar was noted in this area. Rectal examination was negative. The white blood count was 13,000, the temperature and pulse were normal. A diagnosis of partial intestinal obstruction was made. It was thought that the condition was of malignant origin, probably arising in the colon. At operation

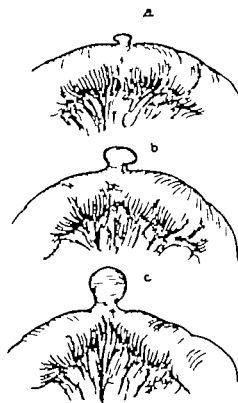


Fig. 1. The size and nature of Richter's hernia of the small intestine are represented diagrammatically. The involved portion of the gut is always on the side opposite the attachment of the mesentery a. Only a small portion may be involved. If very small no symptoms of obstruction are present, yet gangrene may occur. b. A pouch of this size results in partial intestinal obstruction. c. When over one-half of the bowel circumference is involved an intermittent partial obstruction or complete obstruction may result. This is in agreement with Scarpa's observation that when two-thirds of the intestine is strangulated complete obstruction results.

(Dr. R. D. Cattell) the abdomen was explored and it was noted that the entire large bowel was normal while the small intestine was moderately dilated and thickened. In the right femoral area a portion of the ileum was found strangulated in a small femoral hernia (Fig. 3) of the Richter type, so that the wall of the intestine was firmly engaged but the mesenteric border was free leaving the lumen somewhat narrowed so that it produced an intermittent partial obstruction. The femoral ring was enlarged so that the intestine could be freed. The color returned to the strangulated portion although a circular constriction remained, thus obstructing the lumen to about one-third of its normal caliber. The engaged portion appeared viable. Further inspection of the femoral hernia from within showed that the appendix was firmly engaged beneath the former position of the Richter hernia and was included in and adherent to the sac. In order to free the appendix the sac was inverted and appendectomy was performed. An intra-abdominal repair of the hernia by means of a pursestring suture to obliterate the neck was then done. An enterostomy was then performed 6 inches proximal to the strangulated area of the bowel. The patient's condition remained satisfactory throughout the operation. On the third day after operation he developed severe abdominal pain with a high elevation in temperature followed shortly by death.

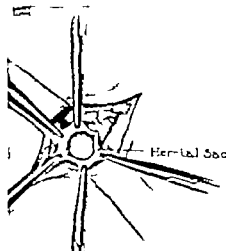


Fig. 1. Case 1. The femoral sac has been opened thus exposing the strangulated intestine and showing this to be a hernia of the Richter's type. Laparotomy was done and the hernia reduced.

These reports show the difficulties of diagnosis. In the first patient there was no evidence of obstruction or of strangulation. We believed that the femoral hernia was the cause of the symptoms, the possibility of a Richter's type of strangulated hernia was not thought of until it was demonstrated at operation. In the second patient an intestinal obstruction was evident but the relation to a possible right femoral hernia was not appreciated until the abdomen was opened. This case is of particular interest in view of the fact that the abscess in the right groin 6 years previously may have been an acute appendicitis. The presence of the appendix in the sac and the dense adhesions may have been factors in the causation of the Richter's hernia. As an inguinal gland was present over the femoral hernia in this patient, it is possible that the abscess may have been related to an adenitis. At operation the strangulated bowel appeared to us to be viable, but undoubtedly the patient died from a peritonitis resulting from the rupture of the strangulated area in spite of the fact that an ileostomy had been done above the obstruction.

In 1906 Burpitt reported the case of a patient with identical findings. In his patient the appendix was present in the right femoral hernia and was non-strangulated but above it there was present a Richter's hernia of the ileum with strangulation. His patient had had a partial obstruction for a month with acute symptoms of 24 hours' duration. Operation was followed by recovery.

A review of the reported cases reveals common findings. This form of hernia occurs more often

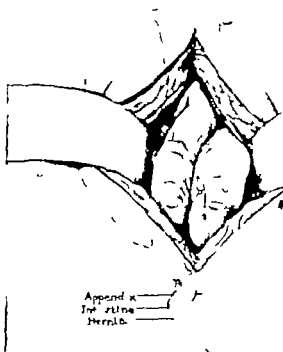


Fig. 3. Case 2. A loop of terminal ileum is seen partially engaged in a femoral hernia. Partial obstruction is present with the proximal loop of bowel being distended. An outline of the caecum and appendix is shown with the appendix incarcerated in the femoral hernia beneath the ileum. The previous incision scar in the femoral region is not shown.

in women than in men and only in adults (Rhodes reported a case in a 3 weeks old negro baby the only exception). The average age is 53 years. The femoral ring is the usual site this being the region involved in about 90 per cent of the cases. The inguinal region is the next most frequent site, in rare instances, this type of hernia is found in the umbilical, obturator, epigastric and intra-abdominal regions. Richter's hernia is more apt to occur in conjunction with a long standing reducible hernia than with one of recent onset or one that is irreducible. At times no swelling can be felt in the ring although there can usually be seen or palpated a small tumor varying in size from that of a hickory nut to that of a hen's egg. The terminal ileum is usually the portion of the bowel that is strangulated. Three patients were found in whom the jejunum was involved and one with the colon in the sac. The most common form is one in which the terminal ileum is involved in the right femoral canal. In this form, only a small portion of the circumference of the bowel is involved and rarely is there a complete obstruction (Fig. 1). The outer portion of the bowel, away from the mesentery is always the portion of the

ileum involved so that the general circulation of the bowel is not impaired

In only one-third of the patients are the symptoms typical of a strangulated hernia with severe obstruction. In the presence of a complete obstruction a mass is usually palpable which is distinctly tender locally and is associated with cramp-like pain in the lower abdomen. Persistent nausea, fecal vomiting, hyperperistalsis, constipation together with the general manifestations of shock are the rule in this minority group. At times a persistent diarrhoea is present but rarely is there mucus or melena present. These patients present such typical pictures of complete intestinal obstruction that operation will be advised early and the results will be fair. While the nature of the cause of the obstruction may not be recognized before operation it will be demonstrated at operation.

By far the majority of the patients (that is two thirds) however have mild and indefinite symptoms suggestive of only partial or beginning intestinal obstruction. These are the ones in which only a small portion of the circumference of the bowel is strangulated. It is quite important to recognize such cases early since gangrene and rupture of this portion of the bowel may occur early and the patient may show no serious general response and no evidence of serious obstruction. Fecal vomiting in these patients is not common and fair results can be obtained in the elimination of gas and fecal matter by means of enemas at a time when local gangrene of the gut is present. A mass may or may not be present but if found is of great importance in making a diagnosis. After the first few hours of strangulation local tenderness may be absent and the pain if present, may be far removed from the point involved. It is in this last group that the operative mortality is very high since operative interference is usually delayed.

As shown in the reported cases, diagnosis is very difficult in only 50 per cent could intestinal obstruction be made out. Diagnosis is made difficult also since in only one half of the reported cases has a palpable mass been present. As our knowledge of this type of hernia increases, diagnosis will be more easily made and the condition more often suspected in patients with femoral hernias presenting symptoms too of partial intestinal obstruction.

The mechanism acting to produce a Richter's hernia is not the same in all cases so that all cases cannot be satisfactorily explained on the same hypothesis. Many times such hernias are associated with old reducible hernias with adherent

bowel and doubtless such adhesions are frequent causative factors. In several instances of Richter's hernia, the case reports show that the hernias have been precipitated by forceful taxis. In addition the hernia has at times been associated with reduction of a hernia *en masse*. Treves reported 4 such early occurrences. Pearse recently advised against the use of taxis because it may cause reduction *en masse*. From the report of cases it would seem that taxis has caused the production of Richter's hernias in several instances. Pressure produced by a truss over the area of the incarcerated bowel may also contribute to the production of a Richter's hernia. Increased abdominal pressure in the presence of a hernia sac has frequently been described as a possible cause. With an incarcerated segment of bowel the normal peristaltic waves in other instances may well free the major portion of the bowel leaving a small diverticulum like portion remaining.

In Richter's hernia the sac is usually small and this factor prevents the engagement of the entire circumference of the bowel. The condition of the strangulated portion of the bowel wall depends on how long strangulation has been present and the size of the neck of the sac. In many of the earlier cases in which gangrene was present subcutaneous rupture led to fecal fistulae. In most of these the fistula persisted in only a rare case did the fistula close spontaneously (Hildanus). Not infrequently the presence of an enlarged tender gland the result of an inguinal adenitis over the hernia sac, has made it difficult to recognize the underlying condition. Of 38 cases of femoral type hernia, collected by Treves, 7 cases had such enlarged glands of the groin.

TREATMENT

The treatment of Richter's hernia is of course surgical. Operation should be done as soon as possible in order to avoid gangrene. In all cases of intestinal obstruction, either partial or complete the usual sites for hernia should be palpated. If the diagnosis is made so early that strangulation is not severe and if after observation circulation to the part is shown intact, simple reduction of the involved portion is sufficient. If the strangulated portion is small and has the form of a gangrenous pouch or diverticulum, it may be plicated or turned in without too great reduction in the lumen. This was done in Case 1 reported in this paper. If larger portions of the bowel are involved resection of the involved loop should be carried out with an end-to-end anastomosis. It is probably advisable to do an enterostomy above the inverted portion or anastomosis to relieve

local pressure, particularly if obstruction has been present.

In the nearly moribund patients two procedures may be carried out. In the first an enterostomy is done the gangrenous portion of the gut being left engaged and a local incision made over the hernia as indicated. This plan is suggested by the fact that when a fecal fistula has formed spontaneously 30 per cent of the patients recover without operation. In the second plan the involved loop is brought out after the plan of Mikulicz and the fistula is closed when the general condition of the patient has improved. Objections can be raised to either of these methods but they appear to offer the least risk in the more serious cases.

The hernia can be repaired intra-abdominally as has been frequently reported the sac is inverted and the neck is ligated. Some patients so treated have remained well over a period of years without recurrence. However the usual anatomical repair either at the time of operation or when the patient is in better condition is the preferred method.

In the cases collected by Treves there was a mortality of 62.2 per cent in those not operated upon. With rare exception all those recovering spontaneously developed persistent fecal fistulae. The operative mortality in his group was 56 per cent—4 patients of the operative group having persistent fecal fistulae. In Bissell's review of the 20 years preceding 1920 the operative mortality was approximately 22 per cent and none of this recent group had a persistent fecal fistula. The mortality is much higher in femoral hernia since gangrene is apt to occur more rapidly due to the fact that the neck of the sac is smaller and constriction is more apt to occur.

SUMMARY

Two patients with Richter's hernia are reported. Both occurred in the femoral region and in each instance the terminal ileum was involved. In one the appendix was incarcerated in the femoral sac beneath the engaged intestine.

The majority of these patients do not have complete intestinal obstruction so that strangulation may not be evident. Diagnosis is rarely made before operation. In all cases with symptoms suggestive of partial intestinal obstruction it is important to examine all possible hernia sites.

It seems reasonable to expect a lowering of mortality following operation with the early recognition of partial intestinal obstruction together with a knowledge of this form of hernia.

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A MUSCLE PEDICLE REPAIR OF DEFECTS IN THE PARIETAL PLEURA¹

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ON the division of thoracic surgery of Harlem Hospital penetrating wounds of the chest due mainly to knives and bullets are of frequent occurrence. We are therefore, frequently presented with the problem of closing a defect in the parietal pleura rapidly and securely. The defect may be due to the knife of the assailant or to the exploratory incision of the surgeon. It was for the purpose of lessening the time of operation and anesthesia (and therefore the operative shock) and producing an air tight closure of the thoracic wall that the operation to be described was designed.

Intercostal pleural defects may be repaired by means of pericostal sutures (as advised by Lillenthal) in which case sutures are passed over the rib above the defect through the pleural cavity and under the rib below the defect, and then tied in such a manner as to bring the two ribs together and obliterate the defect. This is an excellent method in cases of incisions made in so-called 'interval' thoracic explorations, but it has seldom been applicable in our experience to penetrating wounds because of certain anatomical factors.

Penetrating wounds particularly stab wounds, may make irregular defects in the chest wall by fracturing the lower thinner border of the rib thus leaving a rough edge devoid of intercostal muscle which prevents air tight closure even when the ribs are brought tightly together.

Occasionally a small section of rib or cartilage must be resected in order to reach and ligate a bleeding intercostal or internal mammary vessel which otherwise could not be clamped. This makes an irregular defect.

Stab wounds in the chest occur in our experience almost uniformly in one of these topographical groups:

1. *On the anterior chest wall* within a short distance of the sternum and frequently through the costal cartilages. The victim receives the blow unexpectedly usually on the left side, from a right handed assailant.

2. *Near the lower costal margin* in the anterior axillary region. This blow is received as the victim turns aside and raises his arm to protect himself.

3. *In the back* between the border of the scapula and the spinal column. This blow is generally

produced as the victim attempts to escape or to protect instinctively the more vital anterior portion of his body.

An anatomical consideration of these regions will show that near the sternum, at the costal margin anteriorly and near the spinal column, the ends of the ribs are attached at fixed points and at fixed distances. Because of this fixation attempts at bringing the ribs together by pericostal sutures have been unsuccessful frequently in our experience.

Attempts have been commonly unsuccessful, too, in suturing muscle over a defect in parietal pleura. Moreover in the large triangular area bounded by the borders of the pectoralis major and latissimus dorsi muscles anteriorly and posteriorly, and by the costal margin below there is little muscle with which to cover a defect. In addition, the intercostal muscles near the sternum contain fewer muscle fibers than the axillary portion or the posterior portion.

In a few cases we have obliterated a defect of parietal pleura by suturing the diaphragm to the parietal pleura thus plugging the defect and walling off the general pleural cavity. This gives a picture exactly like that found in the first stage of the operation for approaching a subphrenic abscess in which the diaphragm is attached to the parietal pleura. This method has been highly satisfactory in the few cases in which it was used but it has limited use.

In our earlier experience closure of a pleural defect was tedious patchwork which we have been able to obviate by the use of a muscle pedicle, the free end of which is placed into the pleural cavity, (not on the aperture) and held in place by suturing it to the structures at the edge of the aperture.

THE OPERATIVE PROCEDURE

The pectoralis major or the latissimus dorsi muscle was employed in all cases except one. (In that case the pectoralis minor was used because the pectoralis major was lacerated and crushed by the assailant who wielded a scissors with the blades held an inch or two apart. The pectoralis minor was severed at its origin and brought down.) The thickness of the muscle flap should be made slightly larger than the pleural defect so that it will fit snugly into it. The length should be suf-

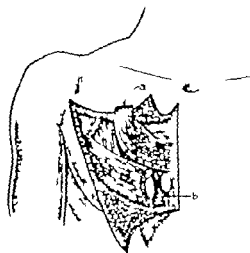


Fig. 1. The muscle pedicle *a* severed and lifted from its bed, ready to be inserted into the orifice *b* into the pleural cavity. Note that the length of muscle required is longer than apparently necessary to reach the pleural orifice. This is made so because the pedicle contracts considerably after it is severed.

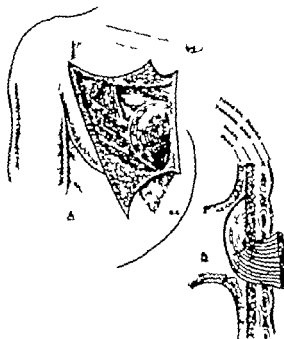


Fig. 2. A. The pedicle has been inserted into the orifice. The bed from which the pedicle was taken may be covered by suturing the border of the pectoralis muscle above to the border below. There is no disadvantage, however, in leaving it open. The pedicle is held in place by sutures to the adjacent muscle, fascia, or perosteum. While the pectoralis major is indicated in these diagrams, the latissimus dorsi may be used in a similar manner. In our experience these two muscles alone were adequate, when made into a pedicle, to reach all pleural defects.

B. This is a cross section of the thoracic wall after the pedicle has been inserted into the defect in the wall. Note the tongue of muscle is well inside the pleural cavity. In one of the cases in which the operation was performed, there was a complication of an infected hemothorax. Drainage was established at another portion of the chest wall and when the pleural cavity was clean, an investigation was made through the drainage wound of the pleural portion of the muscle pedicle and no abnormality was seen, as granulation tissue covered the area in the same manner in which it covered the remainder of the parietal pleura.

ficient to allow the flap to drop into the pleural cavity for a distance of approximately one inch. No harm will come from too long a flap extending into the pleural cavity while too short a flap will have a tendency to retract from it. The flap should be cut in such a manner that the base of the pedicle is near the pleural defect and the point of severance of the muscle is distal to it. When we began this method of closure we found that in spite of measurement of the length of muscle apparently necessary for the pedicle flap we were making too short a flap. This was due to the fact that it contracted after section of the muscle. We overcame this difficulty by increasing the length of the flap so that it was about one and one half times the length apparently necessary. In this way we produced a muscle flap which fitted snugly and without tension. It is of extraordinary interest to see how such a flap is actually sucked into the pleural cavity when placed at the orifice of the pleural defect, and how it will be held in place even without suture in ordinary respiration, to be dislodged only in violent respiration or sharp coughing. It serves as a perfect stopper but should be held in place with a few interrupted sutures or better a continuous suture attached to adjacent muscle or perosteum. It might also be held *in situ* by the pressure of gauze packing.

The advantages are not merely speed and efficiency in immediate closure. The same result might be obtained by tight packing with iodo-

formized gauze. Muscle, however ordinarily withstands infection well except in cases in which it is crushed with great force as in compound fractures and severe lacerations. Therefore, while we may depend upon gauze or fascia as temporary stoppers, they may become useless in a short time because of infection and subsequent sucking wounds. One should not hesitate to sacrifice as much pectoralis or latissimus dorsi muscle as necessary to plug the pleural orifice, since the loss of function is not serious. This may be seen frequently in cases of radical amputation of the breast in which the pectoral muscles are removed *in toto*.

We have employed this procedure in 14 cases with failure in only 1. In this instance we used two flaps in the same defect and one of these flaps was macerated muscle. The failure was partial in that the flaps were competent until the fifteenth postoperative day when they separated. By that time however the mediastinum had become

fixed so that no distress was experienced by the resultant pleural fistula.

The procedure is recommended not only for pleural defects due to penetrating wounds but also for defects following resections involving the parietal pleura. Our experience, however, has been limited to the former type of case.

CORRESPONDENCE

CONGENITAL CYSTIC DISEASE OF THE LUNG

To the Editor: Please permit me to make a belated correction to an article which appeared in *SURGERY, GYNECOLOGY AND OBSTETRICS* for March 1931. This article, entitled *Congenital Cystic Disease of the Lung*, by Doctor Eloesser in the discussion of the number of reported cases of congenital cysts of the lung stated that there had been but 4 American cases, 2 of R. T. Miller, a description of an anatomical specimen by Pappenheimer of New York and 1 of my own.

In 1925 I published (*Bulletin of the Johns Hopkins Hospital*, vol. xxxvii, p. 340) what I thought was the first American case of this condition and reviewed all previous cases that I could find in the literature. Since then I have discovered that Doctor Pappenheimer of New York had published a case in 1912. My reason for overlooking his case was probably due to the fact that it was not published in a medical journal of wide circulation. The other

cases mentioned by Doctor Floesser have been published since the publication of my case in 1925.

Doctor Miller reported only 1 case of congenital cystic lung. The second case he referred to was my own as a careful reading of his article will show since he publishes one of my own illustrations illustrating this case. His failure to refer to my article was due I am sure to the fact that both his article and mine were in process of preparation at the same time, mine having been published only 2 months before his.

A. R. KOONTZ.

JOHN B. MURPHY

Material is being collected for an authorized biography of Dr. John B. Murphy. If any reader of this *JOURNAL* has in his possession letters from Dr. Murphy knowledge of facts concerning his life or any other data, it would be appreciated if they were sent to the Editors. All material will be returned promptly and the source credited.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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MARCH, 1933

THE REVOLUTION IN THE MANAGEMENT OF PHTHISIS

AS recently as 1925 surgical measures were being used for pulmonary tuberculosis by only a few physicians. Today these measures dominate the active treatment of the disease in the leading tuberculosis centers. Although this change has not been brought about by any unique dramatic discovery it is nevertheless an event of prime interest to the medical world because phthisis is still the leading cause of death between the ages of fifteen and forty five years.

An era of hope about the curability of progressive cavernous phthisis has succeeded decades of resignation or false optimism on the part of both physicians and patients during the years when the sanatorium regimen was their only weapon. Nevertheless the sanatorium unaided by surgery has cured many thousands of patients and as long as tuberculosis exists it will probably remain as the indispensable foundation upon which any active treatment will be built. But the fact must be faced that its greatest independent success is for those patients whose lesions are

not extensive and chronic and whose cavities, if present at all, are relatively small and soft walled. The great majority of sanatorium patients belong to the far advanced group in which the death rate without surgery is shockingly high.

The pioneers repeatedly demonstrated during a period of many years that surgery (which term for convenience is intended to include induced pneumothorax) offers to a large group of patients with advanced tuberculosis hope in the face of impending disaster and that these patients contrary to general teaching withstand expertly performed major thoracic operations remarkably well. Yet the medical profession as a whole refused until relatively recently to accept surgery. This has been due in part to the profession's traditional resistance to any change from therapeutic orthodoxy. This wariness has been accentuated in the case of tuberculosis because of the utter failure of many highly praised cures. Other contributory factors have been the great emphasis that has long been placed upon the non therapeutic aspects of laboratory research in tuberculosis, the many ill advised or improperly performed operations that untrained surgeons presented as examples of the surgery of pulmonary tuberculosis and the fact that until recently relatively few competent thoracic surgeons were available.

What resistance to surgery remains is almost wholly passive and is based upon non-familiarity with the subject or upon apathy. It is especially to be regretted that many of our largest state and federal sanatoria, which should have taken the lead in offering life-

saving surgery to their wards have even yet taken no adequate steps to do so

In a large sanatorium in this country, 66.3 per cent of whose patients have far advanced and 28.3 per cent moderately advanced tuberculosis some form of surgery has been used for 77.1 per cent of all patients admitted with the adult type of pulmonary tuberculosis during a recent eighteen month period. It is interesting that the patients themselves who are notably close observers of the results of the different operations used for their fellow patients, rarely reject any recommendation for surgery.

The many operations now available afford great flexibility in the choice of the procedure or combination and sequence of procedures that is most likely both to heal the lesion and to conserve maximum function. Certain patients for whom temporary or permanent phrenic nerve interruption and pneumothorax have been tried and failed present suitable indications for closed or open intrapleural pneumolysis, oleothorax, extrapleural pneumolysis with paraffin pectoral muscle gauze, or rubber bag filling, scalenectomy, temporary or permanent intercostal nerve interruption partial thoracoplasty, or some combination of these operations and may thereby be saved from the necessity of having the more dangerous total thoracoplasty.

Total thoracoplasty is, however, indispensable for selected cases in which much of one lung is actually destroyed. A restricted thoracoplasty often fails to close a cavity and a persisting partially open cavity remains a lesion of grave ultimate significance no matter what gratifying general improvement the patient may have made after operation. A restricted thoracoplasty which fails to close the cavity is a radical and not a conservative measure because a patient who is subjected to the risks that are common to any thoracoplas-

ty should receive the full benefits to which those risks entitle him. Fortunately, it has been found that a very extensive thoracoplasty in three, four or more stages, is as safe, and certainly much more effective, than the restricted one or two stage thoracoplasty that is still too often used. There are two clinics, which happen to be known to the writer in which, during the past eighteen months among a total of one hundred and eleven consecutive patients, representing two hundred and ninety nine major operations, there have been only two deaths during the first post operative month and six deaths thereafter. These patients do not represent a group in which only those with ideal indications for thoracoplasty were included and with doubtful indications excluded, among them were many patients with a poor operative prognosis but a hopeless one without operation.

The modern sequence of measures used in the management of pure tuberculous and mixed tuberculous and pyogenic empyema has vastly improved the results and has dissipated much of the former utter pessimism about the curability of this dreaded disease.

The balanced judgment of the combined medical and surgical points of view is necessary to control undue enthusiasm or timidity and for the selection of the best possible operation for the individual patient. A surgeon's experience with phthisis may not have been sufficiently broad to entitle him to express himself with authority as to what operation is best for the particular patient. On the other hand the mere fact that an internist may be a specialist in tuberculosis and thoroughly familiar with the history of his patient does not necessarily qualify him to pass expert judgment in matters of surgical therapy, if his experience with it has been limited.

The subject as a whole is complex and the margin between safety and danger and be

tween cure and mere improvement is narrow. In many countries an increasing number of medically minded surgeons and occasionally surgically minded internists are apprenticing themselves to active thoracic surgical clinics in preparation for the competent practice of thoracic surgery as a specialty. The medical profession has finally accepted the contributions of surgery as the most hopeful and successful advance that has been made in the treatment of pulmonary tuberculosis since the sanatorium idea was introduced fifty years ago.

JOHN ALEXANDER.

PEPTIC ULCER

CURES or treatments, of peptic ulcer have been numerous usually introduced with enthusiasm that soon subsides to be followed by various modifications and gradually pass into disuse to be repeated with another method.

One explanation of this phenomenon may be found in a study of the natural history of untreated cases which shows peptic ulcer to be a chronic disease with the ulcer as a striking local manifestation characterized by cycles of recurrences and remissions but with a natural tendency toward repair.

Treatment to be rational should be based upon etiology. The possibility of hydrochloric acid because of its constant presence acting as an important etiological factor has been recognized by many notably and recently by Matthews and Dragstedt. This relationship may be emphasized by a consideration of ileal ulcers adjacent to Meckel's diverticula that contain gastric mucosa.

Treatment striving to neutralize hydrochloric acid after its secretion has not been very successful and therefore an attempt at minimizing its secretion has been offered as an improvement. Proper treatment may well

be multiple with efforts being exerted in four directions namely

- 1 Co-operation of the patient (much has been said about the advisability of co-operation between the internist radiologist, and surgeon but of more importance is a change in the patient's attitude from that of a miracle searcher to that of a co-operator with the physician) The methods of education so successful in the management of diabetes might well be imitated in peptic ulcer.

- 2 Social and economic readjustments will usually be necessary preliminaries in securing the essential factor of rest (physical and psychic).

- 3 Medical or non-operative management includes antispasmodics, alkalis or antacids emollients and various miscellaneous measures that are often followed by symptomatic relief which may with difficulty be differentiated from the remissions which characterize the disease. In this connection the statement of Ryle may be repeated 'We should be interested in peptic ulcer the disease and not peptic ulcer the lesion.'

Diets are numerous frequently conflict in theory but are followed by a strikingly similar percentage of favorable results. Dietotherapy should aim not only to neutralize hydrochloric acid already secreted but should also aim to diminish its secretion and should precede and follow all surgical measures.

It is not possible as yet to describe in detail the mechanism of hydrochloric secretion. All of the mechanisms suggested depend upon selective membrane properties. There can be no doubt that the blood base chlorides are the raw materials for gastric hydrochloric acid and that a mechanism exists for converting these simple chlorides into hydrochloric acid which diffuses outward into the stomach (free or combined) while the basic component diffuses in the opposite di-

rection into the blood stream. The phenomenon of 'alkaline tide' is as authentic as is the presence of hydrochloric acid in gastric juice.

If this quotation from Bradley is granted then a salt free or salt low, diet is plainly indicated in an effort to decrease the reserve and in turn the available chloride that might unite with hydrogen to form hydrochloric acid. Such a diet has been utilized in cardiovascular renal diseases, epilepsy, tuberculosis and in peptic ulcer by Krantz and Silver.

4. Surgical. The indications for operative measures may at the present time be outlined as follows: with acute ulcer perforation calls for surgery; hemorrhage for non-operative management; with chronic ulcer non-operative measures may be given a number of trials in duodenal ulcer but because of malignant potentialities prompt surgical measures may be advisable in gastric ulcer.

The usual operative procedures such as resection (which removes the effect and allows the cause to remain) and pyloroplastics or gastro-enterostomies (which destroy or nullify the pyloric mechanism) are frequently followed by return of symptoms and some times secondary ulcer.

Indirect methods such as vagotomy, adrenal denervation, partial devascularization, radiotherapy, physiotherapy, psychotherapy, protein shock and many other types of therapy have been recommended.

The physiological fact that the fundus secretes acid and the antrum alkali has not until recently been applied in treatment. With repeated operations for recurrent ulcers one finds more satisfactory results as more

and more of the fundus has been removed and it seems more rational to remove the cause (the acid) than to remove the effect (the ulcer) and allow the cause to remain.

A direct method of diminishing the secretion of hydrochloric acid by minimizing the area capable of such function (the fundus) as a primary and not a second or third operation, and especially applicable in cases of jejunal ulcer has been carried out by Connell and is now on clinical trial.

By so doing the lesser curvature the *Magenstrasse* an important factor in motility is retained, and the pylorus with its antro-pyloro-duodeno-neuromuscular mechanism so essential in local neutralization and in maintaining general acid base equilibrium is not sacrificed.

Fundusectomy is offered as a compromise between gastro-enterostomy which by some is considered too conservative and gastrectomy which by many is considered too radical. It also complies with the very fair requirement of Balfour that 'it should not interfere with future surgical treatment, should ulcer develop subsequently.

GREGORY CONNELL

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EARLY AMERICAN MEDICAL SCHOOLS

ALBANY MEDICAL COLLEGE MEDICAL DEPARTMENT OF UNION UNIVERSITY

ITS FOUNDING AND DEVELOPMENT

A HAZEL CURRY, M.D. ALBANY, NEW YORK

Assistant Professor of Bacteriology, Albany Medical College

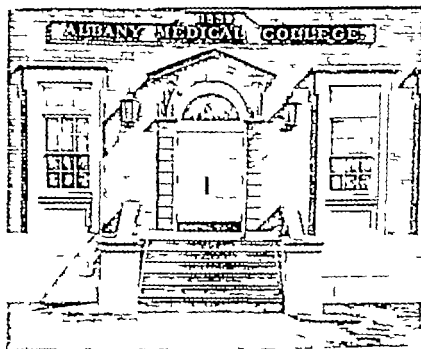
THE Alban Medical College owes its existence to the eighteen years of ceaseless perseverance of Dr. Alden March. A lecture delivered by Dr. March, January 11, 1830 "On the Expediency of Establishing a Medical College and Hospital in the City of Albany" reveals the fact that he had conducted private courses of medical instruction since November 1821. The new college was organized in 1838 and formally opened January 1, 1839. It was incorporated by the New York State Legislature, February 16 and graduated its first class on April 24, of the same year the thirteen members having completed their course in four months. Today this

institution is the second oldest surviving medical college in the state as only one of the three which antedated its inception is now in existence.

Although Dr. March had hoped for a "practical school of medicine, such as is afforded by a well regulated hospital" (2) the Albany Hospital was not opened until 1851. The objects of the corporation set down in the by laws at that time read as follows:

"1. To provide philanthropy by the establishment within the city of a hospital and dispensaries to furnish medical and surgical aid and trained nursing to sick and injured persons.

2. To promote medical education by maintain-



The original doorway as it appears in the new building.

ing a school of instruction in the science and art of medical and surgical nursing and by offering opportunity for clinical and laboratory instruction to medical students." (1)

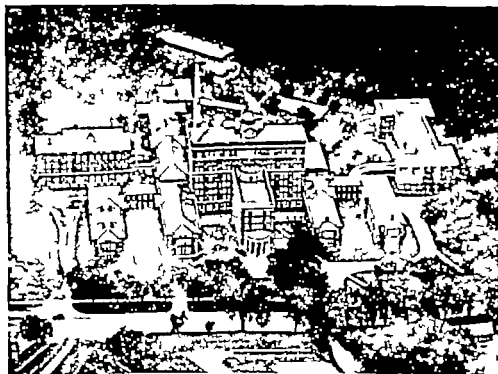
Despite the lack of hospital facilities in the first years of the medical school, practicability was the basic principle of Dr. March's pedagogy as evidenced in his clinical presentations. 'On the first Saturday of the term, Dr. March inaugurated his surgical clinics, held in the college and at which he presented a large number of cases requiring operation or treatment and this new feature in medical education which he introduced soon came to be generally adopted by medical schools throughout the country.' (6)

The first president of the faculty was Dr. March who served in this capacity from 1839 to his death in 1869 a period of thirty years. This remarkable physician and surgeon thus gave nearly fifty years of his life to the founding and development of the Albany Medical College and Albany Hospital. His successors have been Dr. James McNaughton until his death in 1874, Dr. James Armsby until his death in 1875. At this time the title of president of the faculty was changed to that of dean. Dr. Thomas Hun served as dean until his death in 1896. Dr. Albert Vander Veer to 1904, Dr. Samuel B. Ward to 1914, Dr. Willis Tucker to 1915 and since then Dr. Thomas Ordway, under whose administration the new Albany

Medical College has been built and the Albany Hospital reconstructed.

In 1873 the Albany Medical College became a unit of Union College, retaining however, its own name, its own trustees, and its hitherto existing corporate rights. In 1915 the college was reorganized for teaching on a university basis" (5). In 1927 the Albany Medical College and Albany Hospital became legally united by the formation of a Joint Administrative Board to function as a hospital medical college, thereby promoting medical education and affording more effective treatment of patients.

The indefatigable labor of Dr. March a century ago to establish this institution is a tradition of patience, research, and careful planning which has been followed faithfully throughout the ensuing years. This policy has brought to the school recognition for reliability and dependability. The constantly increasing service of the Albany Medical College is evidenced in one of its latest developments—its Regional Extension Department. By means of this regional work, it maintains contacts with physicians throughout a wide rural area, affording them opportunities for acquiring knowledge of the newer developments in medicine and strives to make medical service accessible to all communities. In aiding graduates to keep abreast of the new medical and surgical achievements, as well as in the teaching of under



Aeroplane view of Albany Medical College buildings.

graduates, the Albany Medical College holds to the ideals of the founder. "The value of our pursuits can be estimated only by the value of life itself and of that which alone endears it to its possessor—health. The enlightened and judicious practitioner of medicine is justly ranked among the benefactors of mankind. In proportion as his time and talents are employed in acquiring an accurate and extended knowledge of his profession in the same proportion will he become useful to his fellow citizens, and be entitled to their approbation and support. He should not be devoted to the mere sordid accumulation of wealth. A more noble, generous, and humane motive should hold the first place in his sentiments and actions. Prevent and relieve human misery should be his motto engraved in indelible characters on the tablet of his heart." (3)

BUILDINGS OF ALBANY MEDICAL COLLEGE

During its existence of more than ninety years, the Albany Medical College has had two homes, its present one on University Heights, New Scotland Avenue and its first one on Eagle Street, between Jay and Lancaster Streets. The latter was originally the Lancaster School building which was completed in 1817 having been designed by Philip Hooker, a noted architect of his time. With the passing of the Lancasterian monitorial system of teaching, the Common Council of the City of Albany voted, March 28, 1836 to close the doors of the school. Dr. March ever alert, saw the opportunity to secure this place for his proposed medical college and applied to the Common Council for the building for such purpose in the event of a charter being granted by the legislature. (4) Finally April 16, 1838, the Common Council voted to lease the property to the trustees of the Medical College for five years

rent free, the petitioners having agreed to repair the already dilapidated building and to surrender it in good condition at the end of the term specified.

The new building, modern and capacious, is in direct continuity with the Albany Hospital and in close proximity to the School of Pharmacy, the Albany Law School and the Dudley Observatory, all units of Union University, the New York State Laboratory and the Bender Laboratory. In addition to its own library the medical college has access, through its courier system, to the reference books in the New York State Medical Library, the nucleus of which was formed by books given to the state by the college in 1890.

In the new building the original doorway still stands, the white marble threshold, worn by years of service, has echoed and re-echoed the firm, determined footsteps of the founder as he entered to open the Albany Medical College on the second day of January, 1839. The two colonial fireplaces, one in the library and the other in the trustees room memorialize years of progress which have made possible the Albany Medical College and Albany Hospital of today.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THIF human breast an organ with a peculiar anatomical construction, is during a considerable period of life subjected to various stimuli. It responds to these stimuli be they physiological or otherwise in a manner which is unique and at times mysterious. The superficial location of the breast makes for relatively prompt recognition of anatomical and functional abnormalities. Groups of these abnormalities whether physiological or pathological, have been recognized and described however there is in the mind of most medical men a sense of confusion relative to these conditions—one need mention only the term "chronic mastitis" and place it in the category of rheumatism and like terms. An analysis of the situation immediately suggests the reason for this confusion, namely the lack of concerted study for a sufficient period of time to justify an opinion.

The work of Cheate and Cutler is therefore a most welcome and satisfying contribution to the subject of breast pathology. Their conclusions are the result of some thirty five years of continuous clinical and microscopical study of the breast based upon a definitely established theory and verified by numerous serial sections of the entire breast. For the first time there is established a principle of breast pathology which is clear and concise and which is proved by ample concrete evidence.

The authors divide epithelial growths into two types of desquamative hyperplasia—mazoplasia and the cystiphorous—and neoplasia. The term chronic mastitis and chronic cystic mastitis as they appear in the literature include under their description states of the breast which are more physiological than pathological and also states which are distinctly pathological (cysts and papillomata). These states differ from each other in their etiology, prognosis and treatment so that it is of importance to separate them. The authors have isolated that condition which appears to be more physiological than pathological and describe it under the term of mazoplasia.

Mazoplasia is that condition in which there is a type of desquamation of the epithelial cells in the terminal ducts and their acini with hyperplasia of the pericanalicular and periacinous connective tissue and often with new formation of ducts and acini. The shed epithellum which consists of cells which are irregular stain poorly and are in a state of de-

generation may distend the ducts and acini giving rise to diffuse pain and if the breast is not too fat a generalized fine nodularity which can be felt upon palpation. Cysts do not belong to this state but are associated with an entirely separate and distinct pathological process. In the normal breasts of all women who have borne children mazoplasia is almost universally present in some degree until the menopause and the only pathological state that can be directly traced to it is the formation of fibroadenomata.

Cystiphorous desquamative epithelial hyperplasia is that type of hyperplasia which ends in the formation of cysts. It is entirely different in its biology and morphological appearances to that of mazoplasia although the two may coexist. In mazoplasia the type of epithellum remains stable and forms neither cysts nor papillomata moreover the acini never coalesce. In the cystiphorous type the epithelial hyperplasia may undergo a radical change into epithelial neoplasia the change being traceable morphologically in all stages of transformation. About 20 per cent of all cases of carcinoma of the breast can be definitely traced to be, in within the lesions of the cystiphorous state the supervention occurring in the late fourth and early fifth decade and requires a period of about thirty years to culminate. The authors have shown that the process may be come arrested in the decade of cyst production in others it may stop at the decade of benign neoplasia (papilloma) from which state it may pass into the decade of malignant neoplasia (carcinoma). This fact makes the lesion one of great menace and imminense portent.

The authors believe that papillomata are much more common than is generally supposed. By a study of whole microscopical sections of the breast they have been able to demonstrate their presence when not in the least suspected moreover they have shown that papillomata are generally multiple, as many as 150 tumors having been counted in one microscopical section of the whole gland.

In a discussion of neoplasia there is an interesting description of tumor formation and the association of carcinoma with pre-existing epithelial neoplasia. The authors stress the importance of staining the elastica in studying and interpreting morphological appearances. The problems encountered in carcinoma. Paget's disease of the nipple and benign tumors are expounded in a meticulous manner. There is included a chapter on radiation treatment of carcinoma of the breast. The authors conclude that

THOMSON OF THE LIBRARY THREE PATHOLOGY STRUCTURES, DIAGNOSIS, AND TREATMENT. By Sir G. Leithi Cheate, K.C.B. C.V.O. F.R.C.S., and Max Cutler, B.Sc. M.D. Philadelphia and Montreal. J. B. Lippincott Company 95

since the reported percentage of cures of mammary carcinomas by operation alone vary within such wide limits, it can hardly be expected that the value of radiation can be determined by comparative means. They report some statistical studies but state that several years must elapse before sufficient and accurate data are available. The authors favor the use of pre-operative radiation in selected cases and postoperative radiation in moderate repeated doses.

This work which is claimed by 18 colored plates and 468 illustrations all original is indeed a master piece. It represents the untiring efforts of many years of progressive and thoughtful study based upon a workable hypothesis relative to tumor formation in the breast.

J. A. WOJCIK.

ATLASES of obstetric roentgenology have been wanted ever since the earliest days of the use of the X rays for one of the first applications of X ray diagnostic methods was to the female pelvis and to the fetus. But because of mechanical and technical difficulties only within recent years has it been with in the power of the radiologist to produce roentgenograms of the fetus *in vivo* matrix which from the photographic standpoint could be utilized for publication purposes. Ordinarily the extremely contrasty roentgen films, although rich in detail of both maternal and fetal parts and serving excellently for diagnostic purposes, could not be reproduced photographically and on the printed page without great loss of detail. These difficulties still exist to a certain extent but by improvements in the apparatus and technique of roentgenology and by bringing to the obstetrical clinic the artifices of the professional photographer in retouching negatives, it has been possible for Liepmann and Danellus to publish their beautifully printed and illustrated atlas.

The authors discuss the development of obstetrical roentgenology, the normal position of the fetus, the various changes which may occur and the forces and factors which may bring them about, varieties of pelvic deformities, spontaneous changes in the position of the fetus, a long series of observations on the mechanism of birth, a discussion of the unusual and pathological positions of the fetus, pelvic and fetal menuration, deformities and monstrosities, intra uterine fetal death, and other pertinent questions relating to obstetrics in which the roentgenograms throw light or assist in illustrating. Most of the roentgenograms are accompanied by line drawings which clarify the interpretations. The volume is a valuable contribution to roentgenology and to obstetrics and will undoubtedly be regarded as a classic.

JAMES T. CASE.

IN a compact volume Jacobson has succeeded in making available to medical students and practi-

tioners, a comprehensive, concise and readable discussion of the subject of clinical mycology.

There are ten chapters, entire chapters being devoted to dermatomycosis, moniliasis, maduroty cois, sporotrichosis, blastomycosis, actinomycosis, coccidioides, torulosis, and aspergilliosis. The history of each disease is first discussed, then the etiology, mycology, clinical manifestations, pathology, diagnosis, and finally the treatment. Each subject is very thoroughly covered, and there is a complete bibliography with each chapter.

The illustrations are for the most part very good, the print and paper excellent. The book reads well, and should prove to be of great service to the dermatologist, internist, and general practitioner.

EDWARD A. OLIVER.

THIS work on the individuality of the blood by Professor Lattes, first appeared in Italian in 1913, in German 1915, in French 1919, and now in English. It has been revised and enlarged until at present it consists of 413 pages of general review of the subject and citation of the work of leading students in the field. The author crystallizes the various data, opinions, and methods into a very readable volume. The bibliography of the book is extensive (91 pages).

Attention is concentrated on those constitutional peculiarities of the blood which enable us to distinguish between individuals of the same species. This is what is meant by "individuality of the blood with which this book is alone concerned. These individual characteristics have not been demonstrated by morphology or chemistry but almost entirely by serology.

The hereditability of the blood characteristics caused v. Dugern and Hirschfeld to state that "the bio-chemical structures of A and B groupocytes never make their appearance in the offspring unless they are present in one or both of the parents." If parents contain "peculiar structure," it will be found as a rule in their children. The transmission of the blood groups takes place according to Mendel's law and the so-agglutinable properties A and B behave as dominants, but they are affected by a alleomorphic character, one being derived from each parent, the combination of which give rise to 6 genotypical blood groups. These findings bear out Mendel's laws of heredity in man. Much data are presented on the individuality of the blood as an ethno-anthropological fact. It is clear that the study of the blood groups made go far in solving the origin of races of men. These same principles are becoming well established in forensic medicine to establish the parents of children. Thirty-four pages are given to technique of

FUNDAMENTALS OF CLINICAL MYCOLOGY. Text by Harry P. Jacobson, M.D. With illustrations by Jay French Schellum, M.D. and Howard Morton M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1921.

INDIVIDUALITY OF THE BLOOD IN HEREDITY. 400 pp. Clinical and Forensic Mycology. By Fred Lamm Lattes. Translated by L. A. Howard Horton, M.A. B.M., & Co. (Glas.) London: Oxford University Press, 1921.

GEORGEWELDER AND RÖNTGENALBUM, KLINISCHES UND KLINISCHES RÖNTGENALBUM. GEORGEWELDER AND RÖNTGENALBUM. By University Professor Dr. W. George Welder, and Dr. Gerhard Danellus. Berlin and Vienna: Urban & Schwarzenberg, 1922.

using the points discussed in this book. One section of the volume is given to blood transfusions.

M. H. BARKER.

A BOOK¹ which is just what the name implies—a clinical study of endocrinology has been written by Mazer and Goldstein who are essentially clinicians. The presentation therefore follows the natural clinical sequence of events. The functional phases are taken up in their normal order—puberty, menstruation, pregnancy, lactation, and the menopause. The latent and newest thoughts in endocrinology are fully expressed and a rather considerable portion of this monograph is devoted to therapy. It is this portion of the work if any, which one feels tempted to criticize adversely. Endocrinology is not at present a completed study and endocrine therapy is still in its infancy. Much careful and intensive work must be done before final statements may be made. The authors show a tendency to be dogmatic. The administration of anterior pituitary sex hormone is almost a specific in the treatment of functional uterine bleeding of puberty and maturity. This phase of gynecological practice would be greatly simplified if such were the case.

The monograph is well illustrated. It ends with a bibliography of 649 articles on the subject and is most worth while as a handy and useable reference work on endocrinology in the female gathering together as it does the voluminous literature on the subject. In addition it presents the personal contributions of the authors. These are considerable and lend to the work a most intimate and attractive style. It is a monograph well worth the reading.

RALPH A. REIS.

FOR various reasons the book² by Doll and his collaborators on *Mental Deficiency due to Injuries* is valuable. To some extent it supplies information of unquestioned validity. It emphasizes the challenge already repeatedly made by others that obstetricians should make persistent efforts to discover methods by which the incidence of birth injury can be reduced.

The most important contribution, however is the evidence that careful, resourceful study of individuals suffering from cerebral palsy by psychologists and orthopedists reveal possibilities unsuspected by less thorough methods. Obviously the attitude that among birth injured subjects we have a kind of natural experiment in neuropsychology for studying the relation of behavior to cerebral integrity is both correct and stimulating. Dr. Doll and his co-workers properly and fortunately regard this volume as a preliminary report. As such it has great value and interest.

BRONSON CROTHERS.

CLINICAL ENDOCRINOLOGY OF THE FEMALE. By Charles Mazer, M.D., F.A.C.S., and Leopold Goldstein, M.D. Philadelphia and London: W. B. Saunders Company, 1931.

MENTAL DEFICIENCY DUE TO BIRTH INJURIES. By Edgar A. Doll, M.D., Wlodek M. Phelps, M.D., and Ruth Taylor Mather, M.A. New York: The Macmillan Company, 1932.

AS described in the title Bertwistle's *Atlas*³ a collection of 767 reproductions of positive prints from roentgenograms including examples of most of the pathological lesions ordinarily encountered. Each roentgenogram is accompanied by a few lines of text and sometimes by a descriptive outline drawing. Often the text seems inadequate to illuminate the illustrations considering the author's intention to provide a working guide for the clinician who, without being specially concerned with the technical side, yet desires to know what radiology is capable of revealing to him. It is thought that the presentation of a number of plates with descriptions and clinical notes will enable him to realize which cases are suitable for this form of examination. An interesting chapter concerns milestones in roentgen diagnosis in which the author lists some of the outstanding innovations of each year in the development of radiology.

An unusual style is used for preparing the roentgenographic illustrations as silhouettes. The outline of the soft tissues is scratched in with a needle and a print made after which the silhouette is completed by filling in the background with India ink.

A serviceable atlas for the general practitioner and for the novice in radiology.

JAMES T. CASE.

THE monograph by Hartmann and Bérard discusses all phases of cancer of the tongue.⁴ Following an introductory chapter on the surgical anatomy of the tongue, the author presents an interesting historical review describing the development of our knowledge upon this subject. During the first period (1760) the tongue was looked upon as an object of religious respect because of the function of speech. During the second period (1850) attempts were made to overcome difficulties in operative technique. The third period (1880) was characterized by advances in the knowledge of pathological anatomy. It was during this period that simultaneous ligation of both lingual arteries was performed as treatment for cancer of the tongue. This procedure was followed by diminution in the size of the tumor. During the fourth period (1890) massive ligation was abandoned and leucoplakia was first recognized as a precancerous lesion (Trelat). The most important advance in technique consisted in hemostases effected by ligation of the lingual and external carotid arteries. The fifth period (1920) was marked by a recognition of the importance of block dissection of the neck, and it was during this period that the necessity for external removal of the cervical lymphatic glands secondary to cancer of the tongue was fully established. The sixth period is characterized by progress in the radiation treatment of this condition.

³A DESCRIPTIVE ATLAS OF RADIOGRAPHS; AN AID TO MODERN CLINICAL METHODS. By A. P. Bertwistle, M.B. Ch.B. F.R.C.S. (Ed.) ed. ed. rev. and ed. St. Louis: The C.V. Mosby Company, 1932.

BIBLIOGRAPHIE DU CANCER. Professeurs H. Hartmann et L. Bérard. Directeurs: Dr. A. Chénier Secrétaire: CANCER DE LA LANGUE. By Pierre Schiffo. Paris: Gaston Doin & Co., 1932.

The author emphasizes the important rôle of syphilis in the development of cancer of the tongue. He correctly warns against the use of caustics such as chromic acid, silver nitrate and the thermoplastic cautery in the treatment of leucoplakia, stating that these methods constitute the easiest manner of hastening the transformation of leucoplakia to carcinoma.

Chapters upon the gross anatomy, microscopical structure and the course of the disease are complete, clear, precise and well illustrated.

Surgical excision is advised for the accessible lesions and for the removal of those less accessible.

Complete removal of the cervical lymphatic glands is advised when there is clinical evidence of disease. The technique of radium and X rays in the treatment of cancer of the tongue is described.

This treatise is a useful résumé of the subject clearly presented by a writer who evidently has had considerable experience with the disease. Some radiotherapists will differ with the author upon the wisdom of performing surgical excision of any carcinoma in the tongue regardless of its location. At the Curie Institute, for example, radium is the exclusive method even when the lesion involves the most accessible portions.

MAX CRILEY.

BOOKS RECEIVED

acknowledged in this department, must be regarded as a sufficient of the sender. Selections will be made in the interests of our readers and as

1. *PROCEEDINGS OF MEDICAL EDUCATION*. New York: The Rockefeller Found-

2. *REPORT OF THE GOVERNMENT HOSPITALS AND CHILDREN, ECHOORE, MADRAS*, FOR 1931. Madras: Superintendent, Government

3. *REPORT OF LIFE INSURANCE SERVICE. PROCEEDINGS OF THE TWENTY-SEVENTH ANNUAL CONVENTION OF ASSOCIATION OF LIFE INSURANCE PRUDENTS HELD AT THE WALDOREY ASTORIA*. New York, 1932.

4. *THE PRACTICE SERIES*. Edited by Harlow Brooks, M.D. *OFFICE SURGERY*. By Fenwick Beckman, M.D. Philadelphia and London: J. B. Lippincott Company.

5. *A TEXTBOOK OF SURGERY*. By John Homans, M.D. 9th ed. Springfield, Illinois and Baltimore, Maryland: Charles C. Thomas, 1932.

6. *THE HISTORY OF DERMATOLOGY*. By Wm. Allen Pusey, A.M., M.D., LL.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1933.

7. *THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY. VOLUME III. PRACTICE OF MEDICINE*. New York and London: D. Appleton and Company, 1933.

8. *PICTORIAL MEDICINE*. By Comyns Berkeley M.A., M.C., M.D. Cantab. F.R.C.P. (Lond.), F.R.C.S. (Eng.), F.C.C. Illustrated by Georges M. Dupuy, M.D. 2d ed. New York: William Wood and Company, 1932.

9. *DIE SCHWANGERSCHAFTSDIAGNOSE AUS DEM HANDEL. PRAKTIISCHE UND WISSENSCHAFTLICHE ERGEBNISSE*. By Dr. S. Aschheim. 2d. ed. rev. ed. Berlin: S. Karger, 1933.

10. *CEPHALIQUE TECHNIQUES CHIRURGICALES DE HENRI DELAGENIERE*. Compiled and edited by Yves Delageniere. Paris: Masson et Cie, 1933.

11. *LE GENOU: ANATOMIE CHIRURGICALE ET RADIOGRAPHIQUE CHIRURGICALE OPERATOIRE*. By Antoine Rasset. Paris: Masson et Cie, 1933.

12. *MODERN HUMAN ANATOMY: A COMPLETE SYSTEMATIC TREATISE*. Edited by C. M. Jackson, M.S., M.D., LL.D. 9th ed. Philadelphia: P. Blakiston's Son & Co., 1933.

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X RAY DIAGNOSIS OF ILEUS

THE VALUE OF ROENTGENOGRAMS IN SIMPLE AND STRANGULATED OBSTRUCTION AN EXPERIMENTAL STUDY¹

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IN acute intestinal obstruction as in the majority of surgical emergencies early diagnosis is of utmost importance. All else being equal the earlier the relief of an intestinal occlusion the better is the prognosis. Van Beuren has aptly stated: "The longer a patient with intestinal obstruction lives before operation the sooner he dies after ward." Any procedure therefore facilitating the early diagnosis of this condition which yearly claims so many lives should indeed be more extensively used.

The roentgen diagnosis of ileus has been used much more extensively in the past 5 years than previously, although its true value as a diagnostic procedure in ileus I am sure is not sufficiently appreciated. Obviously the administration of a contrast substance by mouth in suspected ileus is contra indicated and in such instances only plain roentgenograms of the abdomen should be obtained. The procedure first advocated by Schwarz in 1911 has been used extensively as evidenced by the numerous reports (Assmann, Case, Weil, Klobner, Milhaud, Kolbfleisch, Meyer and Brams, Davis, Rabwin, Trémolières, Zadoc Kahn, Kwong, Weber, Milligan and Simon). The value of plain roentgenograms of the abdomen consists of visualization of accumulated gas or gas and fluid proximal to the point of obstruction. Normally gas is

present only in the stomach and in the large bowel and when found in the remaining portions of the intestine indicates the presence of either a mechanical or adynamic ileus. The relative values of roentgenograms obtained in such a way that the junction between gas above and fluid below might be visualized and those obtained to demonstrate an accumulation of gas alone have been discussed by many authorities. In order to visualize fluid levels i.e. the junction between the fluid below and the gas above it is necessary to obtain the roentgenogram by placing the patient the X ray plate and the tube in such positions that the rays will parallel the surfaces of the fluid contained within the intestine. This is accomplished by anteroposterior roentgenograms with the patient in the upright position or with the patient lying on one side or lateral roentgenograms with the patient in the supine position. Gas accumulation alone can be demonstrated on anteroposterior roentgenograms taken with the patient in the supine position. The advantage of the former is that the contrast between the gas and fluid gives a very definite picture. The advantage of the latter is that the usual technique of obtaining roentgenograms need not be varied. Assmann, Case, Weil, Davis, Meyer and Brams, Rabwin and Carter, Trémolières, Zadoc Kahn and Kwong, Weber, Milligan and Simon are

From the Department of Surgery, Tulane University School of Medicine, New Orleans.

TABLE I—JEJUNUM

Time in hours	Simple obstruction of jejunum					Strangulated obstruction of jejunum				
	Horizontal		Upright			Horizontal		Upright		
	Gas	Fluid	Gas	Fluid	Calon	Gas	Calon	Gas	Fluid	Calon
						27	3	27		23
	75		5	5		25	44	20	24	24
4		37	2		3					
5	90	90	20	15	27	26	26	26	22	26
7		22	6	25	27	73	61	73	26	26
	7	20	75	28	5	73	6	73	6	6
	23	90	75	60	27					
20	66	20	23	75	75					

of the opinion that visualization of the gas is sufficient and that the demonstration of fluid levels is unnecessary. On the other hand, Schwarz, Hoesslin, Weil, Benaude and Guinéaux, Kloiber, Milhaud, Wynen, Kolb, Fleisch, Martens, Ochauer and Granger consider the demonstration of fluid levels in cases of ileus of sufficient importance to have roentgenograms made in such a way that they may be visualized.

Relatively little work has been done to determine the time at which X-ray evidence of ileus becomes positive. Kloiber believes that the accumulation of gas in the intestine can be demonstrated roentgenographically within 5½ hours after the beginning of obstruction. Case states that within 6 to 8 hours enough fluid and gas accumulate within the bowel proximal to the obstruction to be visualized by the roentgen rays. Wangenstein and Lynch found in animals that within 4 to 5 hours after complete occlusion gaseous distention proximal to the obstruction could be demonstrated roentgenographically. They believed that the accumulation of fluid proximal to the obstruction was less marked than that seen in humans unless the animal was given a saline infusion. They also found that there was less distention associated with strangulated than with simple obstructions. Subsequently, Goehl, Lynch, Borman and Wangenstein working with varying degrees of strangulation in isolated intestinal loops found that the gas accumulation as demonstrated roentgenologically did not occur as early as in simple obstruction. This latter

finding would seem to vitiate the value of roentgenograms as an early diagnostic procedure in ileus because it is in strangulated obstruction that early operative interference is especially indicated. It is a well known fact that the prognosis is much worse and the urgency for operative relief is much greater in the presence of strangulation than in simple obstruction. The value of plain roentgenograms of the abdomen in the early diagnosis of ileus however is exemplified by the results reported by Rabwin and Carter. The mortality rate during the 8 months that roentgenological diagnoses of ileus were made was 23 per cent as compared with 53 per cent, 37 per cent and 40 per cent, respectively for similar periods of time in 3 previous years.

In order to determine the relative values of roentgenograms taken in such a way that fluid levels might be demonstrated and those taken to visualize the presence of gas alone and in order to compare the roentgenographic findings in simple and strangulated ileus, the present investigation was undertaken. Twenty-three dogs were used in the experiment. In 7 obstructions were produced in the jejunum of which 3 were simple obstructions and 4 were strangulated obstructions. The simple obstructions were accomplished by tightly tying heavy binding tape around the gut. Strangulated obstructions were produced in a similar manner but in addition, the blood supply to the bowel proximal to the obstruction was interfered with by tying rubber bands around the individual vessels in the

The tape was not tied tight enough to produce necrosis

mesentery which ultimately resulted in gangrene. In 14 animals obstructions of the ileum were produced 9 of the simple and 5 of the strangulated varieties. In 2 animals a strangulated obstruction of the sigmoid was made. Plain roentgenograms of the abdomen were made at varying periods of time after the production of the obstruction, one with the animal in the upright position, and one with the animal in the horizontal position. The obtaining of roentgenograms with the animals in the upright and horizontal positions was facilitated by the use of an especially constructed animal board previously described by Ochsner and Gage. In all, 109 observations were made making a total of 218 roentgenograms, 109 obtained in the upright and 109 in the horizontal positions. In the reading of the plates the degree of gas or fluid accumulation was expressed as varying from + to + + + + + representing approximately 25 per cent and + + + + + representing gaseous distention of the intestine of the entire abdomen. Subsequently these were transferred into percentages and are used as a basis for the calculations that appear on the tables.¹

In simple obstructions of the jejunum (Table I) there were no X ray evidences of accumulation of gas or gas and fluid earlier than 3 hours after the production of the obstruction. However, roentgenograms taken 3 hours after the production of the obstruction were positive for gas accumulation (Fig 1) which increased in amount as the time interval increased. The accumulation of gas apparently occurred more rapidly than did the accumulation of fluid (Table I). As early as 4 hours after the obstruction there was evidence of accumulation of gas in the colon, i.e., distal to the point of obstruction the amount of which fluctuated considerably indicating that at times the gas would be evacuated. In general however it increased as the time interval increased.

In strangulated obstructions of the jejunum (Fig 11) as early as 1 hour after the production of the strangulated obstruction, there were accumulations of gas both in the bowel



Fig 1. Roentgenograms taken 4 hours after simple obstruction of the jejunum. A. Horizontal position. B. upright position. There is an accumulation of gas as shown in both roentgenograms but no evidence of fluid levels.

proximal to the obstruction and also in the colon, distal to the obstruction. There were no evidences of accumulations of fluid. The accumulations of gas increased rapidly in amount, much more rapidly than in the simple obstructions. As early as 3 hours after the production of the obstruction, there were evidences of fluid formation as could be demonstrated by fluid levels in the roentgenograms taken in the upright position. The gaseous distention of the colon distal to the obstruction also increased but less so than that in the bowel proximal to the obstruction (Fig 2). From these results, it is evident that in strangulated obstruction of the jejunum X ray evidence of the obstruction is positive as early as 1 hour after the production of the obstruction, whereas evidence of simple obstruction does not become positive until 3 hours after the obstruction. There also occurred distal to the obstruction principally in the colon, gaseous dilatation, which is probably reflex in origin. This was positive in the strangulated obstructions as early as 1 hour after the obstruction whereas in the simple obstructions, it did not occur until 4 hours after the obstruction. The roentgenographic signs not only occurred earlier but were more marked in the strangulated obstructions than in simple obstructions of the jejunum (Fig 3).

¹The percentages so obtained are obviously not absolute but only relative and are of value only when used in a comparative study.



Fig. 3. Roentgenograms of 3 hour obstructions of the jejunum. There is considerably more gas in the strangulated obstructed gut B than in that with simple obstruction A. In strangulated obstruction, B there is also considerable accumulation of gas in the colon i.e., distal to the point of obstruction. Both roentgenograms were made with the animals in the horizontal positions.

In simple obstructions of the ileum (Table II) as early as 1 hour after the obstruction there were X ray evidences of accumulation of gas both proximal to the point of obstruction and in the colon, distal to the obstruction. The earliest evidences of fluid accumulation in simple obstructions were found 3 hours after the obstruction. The accumulation of both gas and fluid rapidly increased as



Fig. 3. Roentgenograms of 7 hour obstructions of the jejunum. There is considerably more gas accumulation in A (strangulated obstruction) than in B (simple obstruction). Both roentgenograms were made with the animals in the horizontal positions.



Fig. 4. Roentgenograms of strangulated obstruction of the jejunum taken 1 hour after the production of obstruction. The roentgenogram taken with the animal in the upright position A, shows gas accumulation and several fluid levels, as indicated by the arrows, whereas the roentgenogram of the animal taken in the horizontal position, B shows accumulation of gas above.

the time interval increased. The amount of gas accumulation in the colon fluctuated considerably, probably due to the fact that the gas distal to the obstruction was evacuated from time to time. In general however it also increased as the time interval increased. In strangulated obstructions of the ileum, there occurred as early as 1 hour after the production of the obstruction an accumulation of both gas and fluid proximal to the obstruction (Fig. 4). There were no evidences of gas in the colon. The gas and fluid accumulation rapidly increased as the time interval increased. It is evident that in the present investigation X ray evidence of ileus (accumulation of gas and fluid) was more marked in strangulated obstructions than in simple obstructions of the ileum (Figs. 5 and 6). There were also greater accumulations of gas and fluid in obstructions of the ileum than in similar obstructions of the jejunum (Figs. 7 and 11).

In only 2 animals were X ray observations made of strangulated obstructions of the sigmoid. In both as early as 1 hour after the production of the strangulated obstruction, there was considerable accumulation of gas and fluid (more of the former than the latter) proximal to the obstruction (Fig. 8). This



Fig 5 Roentgenograms of 5 hour obstructions of the ileum, both roentgenograms being taken in the upright position. A Strangulated obstruction of the ileum B simple obstruction of the ileum. There is a much greater accumulation of gas and fluid in the strangulated obstructed gut, A, than in the simple obstructed gut B. In the roentgenogram of the animal with strangulated obstruction of the ileum A, there is considerable gas accumulation in the colon that is distal to the point of obstruction.

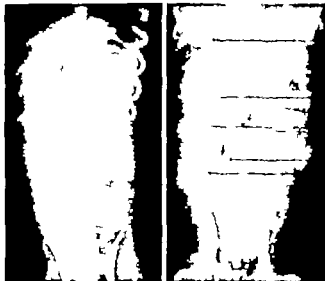


Fig 6 Roentgenograms of 7 hour obstructions of the ileum. A Simple obstruction, B strangulated obstruction. There is a much greater accumulation of both fluid and gas in the strangulated obstruction B than in the simple obstruction, A.

rapidly increased as the time interval increased (Fig 9). In comparing the abdominal

roentgenograms of animals with obstructions of the jejunum ileum and sigmoid it is evident that the lower the obstruction the more marked are the roentgenographic findings (Figs 7 and 10).

TABLE II—ILEUM

Time in hours	Simple obstruction of ileum					Strangulated obstruction of ileum				
	Gas	Colon	Gas	Fluid	Colon	Gas	Colon	Gas	Fluid	Colon
			5	0		25		5	5	
5	37	0	50	5	11	58	4	66	55	11
4	6		6	5		66	50	66	66	30
5	66	4	66	5	41	90	40	90	70	15
7	66	39	66	30	30	95	35	95	80	60
9	66	23	66	66	38	90	30	90	90	50
1	75	4	70	55	45					
24	90	50	90	60	60	87	6	87	8	6
30	95	60	95	80	65					
48	95	55	90	90	35					
55	90	75	90	91	75					
75	90	65	90	90	62					
						Strangulated obstruction of sigmoid				
						Gas	Colon	Gas	Fluid	Colon
						62	62	62	37	6
4						100	75	90	75	75
6						90	90	90	75	90
						90	90	90	100	90



Fig. 7. Roentgenograms of 3 hour strangulated obstructions of the jejunum, A and ileum, B. There is a much greater accumulation of both gas and fluid (indicated by arrows) in the obstruction of the ileum, B than in the obstruction of the jejunum, A. Both roentgenograms were taken with the animal in the upright position.

DEDUCTIONS FROM EXPERIMENTS

The value of roentgenography in the early diagnosis of ileus is exemplified by the present investigations. Simple obstructions of the ileum could be demonstrated roentgenologically as early as 1 hour after the onset of the obstruction by the accumulation of gas proximal to the obstruction. It is true that the amount of gas present in such simple obstructions within the first hour was relatively slight but it was of sufficient quantity to be distinctly abnormal demonstrating that roentgenography as early as 1 hour after the obstruction could be of value clinically as a diagnostic procedure. More important however is the fact that in strangulated obstructions of the jejunum, ileum and sigmoid there were marked X-ray evidences of the obstruction as early as 1 hour after the obstruction, the accumulation of gas being more marked than that which was seen in the simple obstructions. In the obstructions of the jejunum and ileum, as early as 1 hour after the obstruction, there were also accumulations of fluid which were not present in simple obstructions of the jejunum. The fact that roentgenograms of the abdomen taken 1 hour after strangulated obstructions are positive is especially significant because as mentioned operative relief of strangulated obstruction



Fig. 8. Roentgenograms of strangulated 2 hour obstructions of the sigmoid. There is an accumulation of gas in both roentgenograms. Fluid levels are visualized in the roentgenograms taken in the upright position, A. The roentgenogram taken in the horizontal position, B, shows the presence of gas even though the plate was taken only 1 hour after obstruction.

must be secured earlier and is more imperative than that of simple obstruction. A simple obstruction of the bowel in which there is no interference with the blood supply especially if the lower portion of the intestine is involved offers a relatively good prognosis. The urgency for operation is, however materially increased as soon as there is an interference with the blood supply to the gut. These results do not coincide with those of Goehl, Lynch, Borman and Wangenstein who found less distention associated with strangulated obstructions than with simple obstructions. The discrepancy in the results may be due to the fact that Goehl *et al* worked with isolated intestinal loops whereas in the present investigation, the obstruction was produced by occluding the intestine and at the same time interfering with the blood supply in the mesentery a factor which I feel is more apt to be encountered clinically except in cases of volvulus and certain cases of hernia. The greater accumulation of gas and fluid in strangulated than in simple obstructions appears paradoxical, but the explanation may be as follows. As a result of the interference with the blood and also the nerve supply to the gut, a local paresis and decreased ab-



Fig. 9. Roentgenograms of 4 hour strangulated obstructions of the sigmoid. There is considerable accumulation of gas in both plates, that taken in the upright position, B and that in the horizontal position, A. Fluid levels are visualized in the plate taken in the upright position, B.



Fig. 10. Roentgenograms comparing 4 hour strangulated obstructions of the sigmoid and ileum. In the strangulated obstruction of the sigmoid, A, there is a great deal more accumulation of gas than in the strangulated obstruction of the ileum, B. Both roentgenograms were taken in the horizontal positions.

sorbability of the bowel probably occurs. Gas and fluid from the normal intestine above the area of strangulation are forced by peristalsis into the dilated parietic portion of bowel where they remain because of obstruction and diminished absorbability of the intestine. This would explain the discrepancy between our results and those of Goehl *et al.*, who were unable to obtain early evidences of gaseous distention of strangulated isolated loops of intestine. Ultimately gaseous distention of strangulated intestine will occur as the result of normal bacterial proliferation and gas production which however occurs too late to be of any diagnostic value.

It was found in the present investigation that the lower the obstruction the greater was the accumulation of gas and fluid (Figs. 7 and 10). This may be due to the fact that as a rule in the lower obstructions the blood supply of a greater length of intestine was interfered with than in the higher obstructions. Also in the lower obstructions more gas which can be forced into the dilated parietic portion of strangulated bowel may form proximal to the obstruction. It may seem that roentgenography is of relatively less value in obstructions high in the intestinal tract than in low obstructions because the X ray evidences of low obstructions are more

marked than those of high obstructions. However in the present investigation it was shown that as early as 1 hour after the production of the high strangulated obstructions there was sufficient accumulation of gas to make a positive diagnosis of ileus. Moreover as early as 3 hours after the production of the obstruction there was in addition considerable accumulation of fluid.

The relative values of obtaining roentgenograms of the abdomen in the routine anteroposterior position with the patient in the supine position or obtaining them in such a way that the fluid levels could be visualized has been disputed. The author has always felt that roentgenograms demonstrating fluid levels are more valuable than those in which only accumulations of gas can be shown. In the present investigation, however it is demonstrated that the accumulation of gas occurs earlier and is more marked than is the accumulation of fluid. It is also evident that the earliest roentgenographic findings in ileus both of the simple and strangulated varieties is gaseous dilatation of the bowel proximal to the obstruction which can be demonstrated in the roentgenogram taken in the ordinary manner. In those obstructions which had existed longer than 3 hours, however, there was sufficient accumulation of fluid so that

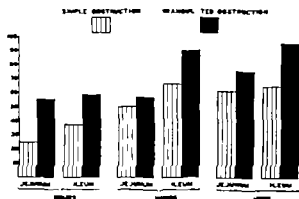


Fig. 1. Graphic representation illustrating the relative amounts of gas accumulation in the bowel in simple and strangulated obstructions of the jejunum and the ileum, as demonstrated roentgenologically at varying periods after the production of the obstruction.

multiple fluid levels could be demonstrated. Even though gas accumulated earlier and more rapidly than fluid in both simple and strangulated intestinal obstructions the author still believes that because when fluid levels can be demonstrated they produce such a typical pathognomonic picture, roentgenograms when possible should be made in such a way that fluid levels may be visualized. Such roentgenograms can be obtained with relatively little difficulty even in the extremely ill patient either by obtaining a lateral roentgenogram with the patient in the supine position or an anteroposterior roentgenogram with the patient lying on the side. In the majority of instances, patients are not too ill to assume the sitting position so that an anteroposterior roentgenogram can be obtained. In this way roentgenograms can demonstrate the junction between the fluid below and the gas above which is of diagnostic importance. Even though the obstruction is of such short duration that an accumulation of fluid has not occurred, gaseous distention can be visualized on roentgenograms taken in this way as readily as in roentgenograms taken in the ordinary position.

Significant is the finding that in the majority of observations in the present investigation and in all of those in which the obstruction had existed 4 or more hours, there was an accumulation of gas in the colon distal to the obstruction. This is undoubtedly due to a reflex dilatation of the colon. It occurred

much more frequently in the strangulated obstructions than in the simple obstructions. The degree of gaseous distentions varied considerably and did not progressively increase with the time interval as did the amount of gas proximal to the obstruction. This was probably due to the fact that from time to time passage of flatus may have occurred from the colon distal to the obstruction. Goehl, Lynch, Borman and Wangenstein observed dilatation of the intestine distal to a strangulated loop of gut and compared it to the paralytic ileus which accompanies peritonitis.

SUMMARY

1. Plain roentgenograms of the abdomen in cases of ileus are extremely valuable as an early diagnostic procedure.

2. The earliest roentgenographic evidence of obstruction consists of an accumulation of gas proximal to the point of obstruction. Gas accumulation occurred earlier and was more marked than was fluid accumulation.

3. In simple obstructions of the jejunum as early as 3 hours and in strangulated obstructions of the jejunum as early as 1 hour after the onset of obstruction there was sufficient gas accumulation to diagnose ileus roentgenologically.

4. In both simple and strangulated obstructions of the ileum there was sufficient accumulation of gas as early as 1 hour after the production of the obstruction to make possible a positive X-ray diagnosis. However the accumulation of gas and fluid was more marked in strangulated than in simple obstructions.

5. The accumulations of gas and fluid were apparently greater the lower the site of obstruction and were more marked in strangulated than in simple obstructions.

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THE APPLICATION OF SURGERY TO THE HYPOGLYCÆMIC STATE DUE TO ISLET TUMORS OF THE PANCREAS AND TO OTHER CONDITIONS¹

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THE subject which I have selected to discuss in this the fourth annual Arthur Dean Bevan lecture seemed to me a particularly appropriate one because much of the pioneer work which has attracted attention to the possibility of the surgical relief of this condition has been done by those who have in some way been identified with this city (Chicago). I refer especially to the careful and painstaking work of Rollin Woodyatt on sugar metabolism to the important cytological investigations of Bensley and finally to the careful study by Russell Wilder of a case of carcinoma of the islands of Langerhans which was associated with evidence of hypoglycæmia. A particular reason however for selecting this subject was the fact that in the last few years at the Barnes Hospital we have had the unusual experience of encountering 6 cases of proved tumor of the islet tissue. In 3 of these the patients were operated upon with successful results and in the 3 others in which no operation was performed the tumors were found at autopsy. In addition the material obtained at an autopsy at another hospital has been studied by our department of pathology.

Before the discussion of the subject in detail it may be well briefly to review our current conceptions of the regulation of the sugar in the blood. The sugar equilibrium is maintained by the counterplay under nervous control of a number of factors of which the secretions of several glands are perhaps the most important. Insulin from the islands of Langerhans of the pancreas tends to diminish the amount of blood sugar and on the other hand, the secretions from the medulla of the adrenal gland from the anterior lobe of the pituitary² and from the thyroid all tend to

increase it. Despite the antagonistic action of several forces the amount of the blood sugar in normal fasting individuals, that is before breakfast, does not vary greatly but is usually found to be about 0.10 per cent. or about 100 milligrams of sugar in 100 cubic centimeters of blood.

The introduction of insulin as a therapeutic agent was soon followed by dramatic demonstrations of the danger which may arise from reducing the amount of the blood sugar too far below the normal level. Accordingly a syndrome of hypoglycæmia has become recognized. The clinical manifestations of this condition are numerous. It is necessary to mention some of these in order to understand the picture presented by an active tumor of the islands of Langerhans.

The most commonly observed symptoms of hypoglycæmia are a feeling of malaise, lassitude, inability to perform mental or physical work, often accompanied by trembling and sweating. The face may be alternately pale and flushed. There may be a fall in temperature. Simultaneously with these symptoms there is usually a sensation of hunger which may be extreme and even agonizing. Carlson and his associates have shown that hypoglycæmia is associated with violent contractions of the stomach. One of Harris's patients states that he felt as if he would die if he could not have food immediately. Yawning and mental confusion often accompany the sensation of severe hunger. The pulse is usually accelerated. But some of the most important and striking symptoms are related to the nervous system. Mental confusion resembling alcohol intoxication is very common and crises resembling epileptic convulsions have been noted so often that the first diagnosis made in several of the reported cases of islet tumors has been that of epilepsy. In most cases however it can be

¹Ordinary commercial pituitary extract which is made mostly from the posterior lobe also increases the blood sugar. The action of adrenalin is supposed to be due to the liberation of sugar from glycogen stored in the liver.

This paper was given by the senior author at the fourth annual Arthur Dean Bevan Lecture before the Chicago Surgical Society and the Chicago Institute of Medicine on December 14, 1921.

noted that the crises are different from those of true epilepsy of the grand mal type. Sigwald in a recent excellent monograph on hypoglycemia states "Most often these attacks are partial limited intermittent and irregular, the contractures have abnormal characteristics, one can observe hysteriform crises with contracture in the arc of a circle and great agitation or tetaniform crises with permanent contracture in opisthotonus or in another attitude. These extensive convulsions deserve the name of 'epileptiform crises.' Convulsions limited to one side of the body and even to the face or to the extremities have been recorded. Amnesia is another common symptom of great value. The patients seldom remember what they have done or said during the periods of mental and psychic abnormality. In some cases even localizing signs of disorder of the central nervous system such as a Babinski sign, disturbances of the pupils etc. have been noted in connection with the hypoglycemic state. In the more severe cases, coma is frequently observed. It is unnecessary to enumerate all of the various clinical phenomena which have been found to be associated with a state of hypoglycemia. It is important, however, to emphasize that in many cases the neurological or psychiatric aspects of the condition are so prominent that many of the patients with chronic hypoglycemia have been referred primarily to neurologists and psychiatrists for treatment. Sigwald refers to several recent reports of chronic psychoses in patients who were taking insulin which disappeared at once after the cessation of insulin treatment. It is interesting also that repeated observations have been made of hemorrhages into the central nervous system in severe induced hypoglycemia. This observation perhaps has a special bearing on one of our cases which will be noted later.

There is, of course, no definite level of the blood sugar at which the symptoms of hypoglycemia are likely to appear. In general, however, the most severe manifestations are associated with the lowest findings of blood sugar. When the blood sugar diminishes to 50 milligrams or less per 100 cubic centimeters, the effects are likely to be severe.

Apparently the first suggestion of the possibility that the blood sugar might be excessively lowered spontaneously by an abnormal activity of the islet tissue of the pancreas was made by Seale Harris of Birmingham, Alabama, in 1924, in a paper entitled "Hyperinsulinism and Dysinsulinism." In this paper he reported 12 patients with blood sugar values of less than 70 milligrams nearly all of whom presented many of the symptoms which have already been described as those associated with hypoglycemia. Since one does not find such low blood sugar values in starvation he concluded that probably they represented an expression of spontaneous hyperinsulinism. Jonas in the following year added another case in which because the most striking symptoms were epileptiform the patient was sent to an institution for epileptics and died there. This same case was later reported by Hartman.

The most striking evidence however of the occurrence of hyperinsulinism or dysinsulinism was presented in 1927 in the important report by Wilder, Allan Power and Robertson of their dramatic case. This concerned a man, 40 years old who for more than 2 years had had attacks consisting of syncope, parasthesia of the tongue and lips, asthenia, sweats and trembling. These attacks occurred just before a meal or after unaccustomed exercise and the patient had discovered that he could escape them by taking food or sweetened drinks. On one occasion he was comatose for a couple of hours and had been revived by injections of adrenalin and of dextrose. A sugar tolerance test showed a rise from 85 to 215 milligrams per cent at the end of a half hour and then a fall to 31 milligrams per cent three hours later. Finally it was calculated that this patient required as much as 25 grams of dextrose per hour to avoid his attacks. An exploratory operation by W. J. Mayo revealed a large nodular pancreas with metastatic tumors in the liver. From tissue recovered at autopsy a month later the tumor was found to be a primary carcinoma of the islands of Langerhans, and it was found to contain as much as 40 units of insulin to 100 grams of tumor. In the following year (1928) Thalhimer and Murphy

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Fig. 2



Fig. 3.

Fig. 2 Section taken through a very cellular portion of the tumor. Most of the cells seen are similar to the so called beta cells of the islands of Langerhans both in structure and function. (Barnes Hospital, Case 2.)

Fig. 3 Section which was taken through a more mature portion of the tumor. The appearance in this section is

that of collagenous connective tissue.

Fig. 4 Connective tissue with an apparent disappearance of cells. This probably represents a mature adenoma. (Barnes Hospital, Case 2.)

nodule which measured 1 centimeter in diameter. The authors as well as Dr. Bensley, who also examined the tissue, believe from the microscopic appearance that it is a true tumor and not merely a hypertrophic island. Because of their inability to demonstrate either alpha or beta granules in the cells it was decided that this was not an active tumor. Certainly there was no clinical evidence of activity because the patient had severe diabetes instead of hypoglycemia. Thus of the 4 cases one was definitely associated with hypoglycemia, another had symptoms suggestive of it, a third had no clinical evidence of it but the amount of the blood sugar had not been determined and in the fourth the patient had severe diabetes instead of hypoglycemia.

In 1928 MacClenahan and Norris had reported their very definite case of adenoma associated with severe signs and symptoms of hypoglycemia in a man 42 years old. At autopsy the tumor which was 1.6 centimeters in diameter was found to be plainly encapsulated. There were no mitotic figures and the cells for the most part resembled beta cells of normal islands. Neighboring pancreatic tissue showed some hypertrophied islands.

Since October 1930 3 patients have been successfully operated on and the results of the removal of the tumor tissue associated with hypoglycemia.

The first case, which has been reported by Parker, Grove, Fisher and Langer, was a young man of 19, a student at a medical school, who was referred to the neurologic department by a physician who diagnosed the condition as epilepsy because of repeated seizures which had been present for a year. The patient was worthy that these attacks occurred at breakfast. Under the strict discipline of the school these attacks had been controlled and even on occasions when they occurred the boy was often noted getting dressed and at the breakfast table. On several occasions he had been taken to the hospital for medical measures. On one occasion he was in the streets of a large city and had an accident and had no recollection of what had happened. When he was in the hospital various attacks he was always hungry. Food, especially sweets, seemed to relieve the attacks. Blood taken during the attack showed only 46 per cent sugar. A 1.5 centimeter tumor was made. On October 22, 1930 Dr. A. J. Well encapsulated adenoma from



Fig. 5. Low power view of the tumor removed at the first operation. This was probably much older than the second tumor removed from the same patient later. See text for discussion of it. (Barnes Hospital Case 3)

border of the pancreas at about its midportion. The tumor was somewhat larger than most of those which have been described, measuring 3 centimeters in long diameter. The postoperative course was uneventful, the blood sugar was promptly restored to a normal level, and the patient's symptoms have been entirely relieved.

Our second operative case has also been separately reported. It concerned a farmer, aged 44 years, who had been in good health until October 1930. One morning at this time he noticed that while doing his chores about the farm before breakfast he became mentally confused. He described the symptoms as similar to those of alcoholic intoxication. After eating breakfast he felt normal again. His next attack was early in the morning about 1 week later when he noticed the same sort of feeling. Attacks began to be more frequent and a little more severe. Early in December 1930 he had his first very severe attack, at which time he became unconscious and had to be carried into the house. He was given food and in a few moments was feeling normal again. His memory as to what took place during this seizure was considerably confused. He consulted his family physician who could find nothing abnormal on physical examination. During the next 3 months the patient was examined at two different clinics, where the diagnosis of a possible brain tumor was made. He was given phenobarbital, with no improvement. He now began having attacks before rising in the morning during which, according to his wife, he became much confused spoke at random, and at times fell from his bed. She also noticed twitching movements, especially about the face. There were never any generalized convulsions. At another clinic it was found that he had a patho-

logical condition of the gall bladder and this organ was removed along with the appendix. There was no amelioration of the symptoms. It was at this time that his wife noticed that, if she fed him several times at night, his attacks could be prevented. He also began carrying candy around in his pockets during the day and noticed that frequent eating of it prevented the seizures. He was referred to us in January 1931 for study. Drs. Womack and Gnagl had made a tentative diagnosis of an islet tumor on the basis of the patient's history before he entered the Barnes Hospital for study.

General physical examination gave entirely negative results. The blood pressure was 128 systolic and 74 diastolic. There were no positive neurological observations. The disks were normal, as were the visual fields. Roentgenograms of the skull were indeterminate. The basal metabolism rate was plus 3 per cent. The urine was normal red blood cells 5,230,000, and white blood cells 6,600. The differential count was normal. Hemoglobin was 90 per cent. The Wassermann and Kahn reactions of the blood were both negative. Phenolsulphone phthalein excretion was 80 per cent in 3 hours. The blood amylase determination by Elman's method was 7.5 units (5 units normal). Blood non-protein nitrogen was 37 milligrams per hundred cubic centimeters.

The patient was given his regular evening meal. This was followed by 300 cubic centimeters of milk at 7 p.m. and 300 cubic centimeters of sweetened grape juice at 9 p.m. He was not given any more food that evening. At 6:15 a.m. he was found to be awake. His face was expressionless, his pupils somewhat dilated and though he answered when spoken to, his answers were incoherent. There was a generalized coarse tremor and the respirations were mildly Biot in character. A specimen of blood was taken for a sugar determination. The patient was then given 120 grams of dextrose by mouth (estimated weight 150 pounds or 68 kilograms). Ten minutes after receiving the dextrose he was again alert and did not remember any of the preceding events. No more food was given and blood specimens were taken at hourly intervals. At the end of 7 hours he again became slightly confused, he began to perspire. It was noted that the reflexes were slightly hyperactive. He soon presented the same clinical picture that he had presented earlier in the morning, and further food was given, with immediate relief. The foregoing description is that of a fairly typical attack and was observed on several occasions.

The reaction to epinephrine was found to be a definite one. The patient was temporarily relieved of his confused state and showed at the same time a rise in blood sugar.

The reaction of pituitary extract was delayed and irregular though there was a slight rise in blood sugar.

February 4, a laparotomy was performed (E.A.G.) The pancreas was exposed through the gastro-



Fig. 6 left. Second tumor from same patient as Figure 5. Imperfectly formed lobules and sinuous cords of epithelioid cells. Hematoxylin and eosin stain. High power (Barnes Hospital Case 3.)

Fig. 7 Mallory stain showing the connective tissue dividing the tumor into imperfect lobules. (Barnes Hospital Case 3.)

colic omentum and at about the junction of the body with the tail on the anterior surface a small tumor was seen about one centimeter in diameter. It showed through the posterior peritoneum as a dark spot suggestive of a small hemorrhagic area. It felt firm. When the peritoneum was incised it was found that the tumor could not be shelled out of the pancreatic tissue and it was therefore necessary to dissect it out with a small margin of normal pancreatic tissue around it. Before this was done a pursestring suture was placed in the substance of the pancreas in order to control hemorrhage. The vessels in the region of the tumor were all enlarged. The edges of the tumor bed were brought together and the peritoneum was then closed over. A small rubber drain was placed over this and brought out through the left side of the abdomen by means of a stab wound.

Convalescence was somewhat stormy at first. Immediately after the operation a pulmonary infection developed which however was not very severe. On the second day after operation there was a fairly rapid edema of the lungs. The patient was placed in an oxygen tent and given atropine. His condition improved rapidly. A pancreatic fistula developed several days later. This did not cause any skin excoriation and was rapidly closing at the time he left the hospital. Since his operation he has not had any more attacks, although his diet has been one containing no more carbohydrate than that of a normal individual. Fasting for 12 hours has failed to bring on an attack. In fact the blood sugar at this time was 99 milligrams per hundred cubic centimeters. At no time since operation has it been lower than this. We saw this patient again in December, 1932

nearly 2 years after his operation. He was in excellent health and he stated that he had had no further attacks of his former trouble.

We were fortunate in being able to submit the tumor tissue to Prof. R. R. Bensley of the University of Chicago who was present at the time as a visiting professor of anatomy in Washington University. Dr. Bensley is recognized as an authority on the cytology of the pancreas. Excerpts from his report follow. While examination of the fresh cells was in progress, another portion of the fresh material was stained with neutral red in a 1:10,000 concentration in physiological solution of sodium chloride. It should be remarked that when normal islands of Langerhans are so treated the minute granules which the cells contain stain rapidly a bright yellowish red color with the neutral red. The cells of the tumor showed with the neutral red a curious reaction which was observed also in the case reported by Carr Parker Grove Fisher and Larimore. In that case the granules in groups of cells stained intensely with neutral red, while other groups of cells clearly containing granules failed to stain. Other cells of the same tumor showed scattered granules staining with neutral red dispersed among other granules which failed to stain.

"I was of the opinion when I examined this first tumor that the failure of the neutral red to stain every cell was due to the mechanical difficulty of penetration of the dye but the examination of the present tumor in which by the experience gained in the study of the first it was possible to take precautions to avoid this, indicates that in both tumors there are granules present which stain readily with neutral red and other granules which do not stain



Fig. 8



Fig. 9



Fig. 10

Fig. 8 The close approximation of the duct and islet tissue in the vicinity of the central core. (Barnes Hospital, Case 3.)

Fig. 9 Higher magnification of a portion of the same

area as that seen in preceding figure. (Barnes Hospital, Case 3.)

Fig. 10 Cytoplasmic inclusions. (Barnes Hospital, Case 3.)

with neutral red. In the tumor now under description scattered cells, not in groups, stained exactly as a normal beta cell of the islands of Langerhans—that is to say, the cells were packed with granules which stained brightly with neutral red. These cells did not occur in groups, as in the Carr-Parker-Grove-Fisher-Larimore case but were individual. Many cells contained scattered neutral red stained granules mingled with granules of about equal size which refused to stain but the majority of the cells contained granules which stained only faintly with neutral red.

Two other observations were noted in all the cells of the tumor: a few granules, about the size of a zymogen granule, in the pancreatic acinus, more highly refractive than the regular granules and staining brightly with neutral red; a few cells contained rather indistinctly outlined amorphous bodies which stained rather faintly with neutral red. As the preparation became old, the cells behaved like island cells under similar circumstances: vacuoles formed in the cytoplasm, and the granules disappeared.

The tumor was slightly irregular in outline and, as already mentioned, was not encapsulated. At portions of the surface it was separated by broad strands of collagenous connective tissue from the neighboring pancreatic lobules, but at other points it was actually in contact with pancreatic tissue and at one point in the tumor the pancreatic acinus tissue was not only in contact with the tumor tissue but was actually in epithelial continuity with it.

The substance of the tumor itself was imperfectly divided into lobular masses by heavy strands of collagenous connective tissue. In these bands, portions of pancreatic ducts were seen and, in addition, masses which presented the appearance found in lobules of a pancreas whose ducts have been

ligated. In the latter masses, regenerated acinus cells, such as those which have been described by Grauer in his account of regeneration in the pancreas of the rabbit, were to be seen. There were also present in this tissue small and large groups of normal island cells, also probably of recent origin.

The acinus cells seen in these complexes had evidently arisen by differentiation from duct epithelium since they presented all grades of advance in the regenerative processes as follows: (1) individual acinus cells surrounded on all sides by duct epithelium; (2) groups of two or three acinus cells; and (3) well individualized small acini. Ducts were in many places continuous with the epithelial masses of the tumor itself. The tumor tissue presented different aspects in its different parts, and these different aspects I conceive to be the different stages in the progress of this growth.

One lobe separated from the others by strands of connective tissue presented the appearance of an enormous, overgrown island of Langerhans, except, as appeared later, for the fact that the cells which composed it were not normal island cells of either category but abnormal tumor cells of island reference. This portion of the tumor consisted of anastomosing cords of epithelial cells separated by wide sinusoidal capillaries, the endothelium of which was almost in contact with the epithelial groups, a minimum of reticular connective tissue being interposed.

In the adjacent portion of the tumor the proliferation of the epithelial elements had exceeded the rate of growth of the vascular components, and in this portion of the tumor an extraordinarily large mass of epithelium was traversed only by a normal number of capillary blood vessels, and these showed a tendency to become separated from the epithelial elements by an increase in the layer of connective

tissue outside of the endothelial tube. In some of these cellular masses there was a breakdown of cells forming spaces containing scattered necrotic epithelial cells and much blood, the blood vessels having evidently ruptured into the space provided by the death and dissolution of the epithelial cells.

In the third section of the tumor an appearance which approached that in the Carr Parker Grove Fisher Larimore case was attained. Groups of epithelial cells were separated from one another by wide strands of hyalinized connective tissue containing blood vessels. Degenerative processes in this tumor were not nearly so manifest as in the tumor removed by Dr. Fisher, but in places the cells had completely broken down and the place formerly occupied by them was now filled with blood, a few scattered epithelial cells and in some instances isolated groups of tumor cells attached to the walls.

Sections of material fixed in chrome sublimate and in formol Zenker stained with Bowie's stain or Bensley's neutral gentian revealed the fact that only a small proportion of the cells of the tumor had the characteristics of normal beta cells.

Examination of the material fixed in chrome sublimate or formol Zenker stained with neutral gentian or with Bowie's stain showed that many cells in this tumor contain beta granules associated with granules of another sort. This observation recalls that made by Robinson that in his tumor some cells contained both alpha and beta granules.

The cytologic study of this and of the preceding tumor and of the one reported by Robinson, indicates that in this case the tumor is not one composed of normal island cells but on the contrary one composed of cells which, while having a considerable resemblance to island cells, yet differ from them in important details. These differences consist of the production of a granular secretion antecedent, which differs in important details from the normal content of the island cells, and in the presence in these cells of a chromophil substance unusual to island cells and found in normal pancreas only in acinus cells.

The normal pancreas as is well known contains a very considerable excess of island tissue and yet ordinarily does not yield to the general circulation an excess of insulin. The fact that a tumor of such meager proportions could produce the symptoms of insulin shock and yet not be responsive as the normal islands are to the mechanisms that ordinarily regulate the export of insulin from the pancreas, is possibly to be found in the fact that the lesion under discussion is an abnormal cell type which, to be sure, resembles island cells but is not identical with them.

Some doubt exists in my mind as to whether this tumor should be regarded as adenoma or carcinoma. The failure to form a definite capsule and the inclusion of normal pancreatic elements in the tumor itself seem to favor the latter diagnosis.

Our third and last case presents the unique feature of having two tumors and two opera-

tions for their removal with a final successful outcome. This case has not been reported elsewhere.

A young man aged 22 years of Jewish extraction was first admitted to the Barnes Hospital on March 14, 1928, on the neurological service for the diagnosis of epilepsy.

He had had tuberculosis of the hip at the age of 3 for which he wore casts and braces until the age of 13, scarlet fever at the age of 15. In 1926 at the age of 20 he graduated from the St. Louis School of Pharmacy apparently a fairly capable student and since then has been working as a druggist.

In March 1927 he noticed twitching in his legs after walking a few blocks. This occurred particularly at the end of his day's work when walking home from his drug store which usually occurred just before dinner. After dinner he could walk a much longer distance without observing any twitching of his legs. In January 1928 he noticed a similar twitching of his arms just before dinner and with this there was a feeling of drawing of his face associated with pallor and sweating. On one occasion he stared straight ahead for a minute or two and after being put to bed made an immediate recovery from these symptoms. In February 1928, he had several fairly typical attacks of petit mal which lasted from 3 to 5 minutes. There were no after effects but often there was a feeling of nervousness and weakness just preceding the attacks.

Upon admission to the hospital the patient was found to be intelligent and co-operative. His memory was good and he appeared to be interested in the examination, appearing neither depressed or excited. There was a slight slurring of speech and occasional twitching movements of various muscle groups. His gait was what was to be expected from the ankylosis of the left hip with a scoliosis. The blood pressure was 110-60 the pulse 70. A nystagmus was present and a discharge from the right ear apparently from a chronic mastoiditis. No blood sugar determination or blood chemistry was done. All the routine laboratory work including a blood Wassermann, was negative. The patient was considered atypical of epilepsy and was discharged for further observation.

Three months later he was readmitted to the hospital with no apparent change in his condition. At this time a tonsillectomy was performed.

On January 30, 1931 the patient was readmitted to the hospital. During the past year the attacks had become more frequent and more severe. Examination at this time showed him to be still intelligent and co-operative. No blood chemistry determinations were made because of certain observations by the psychiatrist who was taking care of him at this time and who thought his condition to be due to sexual repressions. He was treated by psychoanalysis and hypnotism with no apparent improvement.

On August 8 1931 he was again admitted to the hospital and on questioning him at this time the patient gave only nonsensical answers. His attacks continued to be severe. No additional positive findings were noted on examination.

On May 9 1932 he was readmitted to the hospital for the fifth time. He had now begun to have several attacks a day of petit mal. There was also a progressive muscular weakness. He entered the hospital during one of his attacks of petit mal. A sample of blood was taken immediately and the sugar was found to be only 35 milligrams per hundred cubic centimeters. The blood calcium was 5.5 and the phosphorus 10.6. He was given 50 cubic centimeters of 50 per cent glucose intravenously immediately. After receiving the first 25 cubic centimeters he aroused and was able to answer questions. When all of the 50 cubic centimeters had been received he was able to sit up and talk intelligently. His memory of the attack was poor. He had entered the hospital in the evening and after receiving the intravenous glucose he was given sweetened fruit juices to drink. On the following morning at 5 o'clock he had another seizure which disappeared 10 minutes after drinking a glass of orange juice.

On May 11 carbon dioxide combining power of blood was 73.51 per cent, calcium 10.9 milligrams per cent, phosphorus 3.6 milligrams per cent.

A sugar tolerance test was performed with the following result:

	Milligrams per cent
7-45 a.m. fasting blood sugar	58
8-12 a.m. glucose	
8-40 a.m.	112
9-10 a.m.	133
10-10 a.m.	117
11-10 a.m.	60
12-10 p.m.	53
1-10 p.m.	43
2-10 p.m.	40

Urine collected from 8-40 a.m. to 11-10 a.m. negative for sugar.

On May 13 the patient was found by Miss Kendall to have an intelligence quotient of 60. Her conclusions state, "this is evidently not representative of patient's original intellectual endowment. Scattered distribution of success and failure, the relatively high vocabulary and the difficult co-operation would indicate this even if the history were not known. Objective findings, Stanford lowest failures all in reversing digits and in making sentences to include three given words (9 years). The best work in inductive reasoning (14 years) and in vocabulary (12 years)."

On May 19 after receiving 500 cubic centimeters of 10 per cent glucose intravenously a laparotomy was performed (E.A.G.) An upper left paramedian

incision was made and the pancreas was exposed through the gastrohepatic omentum. A small hard tumor was immediately felt and seen on the anterior surface of the pancreas at about the junction of the left and middle thirds. The tumor was clearly exposed and was seen to project slightly forward. One portion of it was so hard that it suggested calcification. There was a slight bluish discoloration of the tumor which made it distinct in appearance from the rest of the pancreas. A pursestring suture of catgut was placed around the tumor bed and the tumor removed. This was easily accomplished and there was only one small vessel at the pedicle. It was not necessary to remove any appreciable part of the normal pancreatic tissue. When removed the tumor was found to be about 1 by 0.8 cubic centimeters. It was immediately placed in fixing fluid, a rubber dam drain was inserted down to the pancreas and the wound was closed in layers. The operation was prolonged because of frequent attacks of apnea. The anesthesia used was nitrous oxide-oxygen with a little ether.

At 11 a.m. (immediately following the operation) the blood sugar was 100 milligrams per cent. Five hundred cubic centimeters of 10 per cent glucose were given intravenously followed by 3,000 cubic centimeters of physiological saline solution subcutaneously.

At 3 p.m. the blood sugar was 212 milligrams per cent. 4 p.m. the blood sugar was 170 milligrams per cent.

May 20, 9 a.m., the blood sugar was 122 milligrams per cent, no convulsions had occurred, 500 cubic centimeters of 10 per cent glucose were given intravenously.

May 21, 9 a.m. the blood sugar was 96 milligrams per cent (fasting). Five hundred cubic centimeters 10 per cent glucose given intravenously.

May 23, 9 a.m. blood sugar 102 milligrams per cent (fasting). Blood calcium 9.6. Blood phosphorus 3.9. Later in the day he had a convulsion, the first since his operation. He was given some fruit juices during the day by nasal tube.

May 24, 9 a.m., blood sugar 34 milligrams per cent (fasting). Carbon dioxide combining power 69.7 volumes per cent. The patient had another convulsion which was controlled by the drinking of fruit juice.

From then on during the next few days the patient was given large amounts of carbohydrates until on May 28 he was receiving 600 grams of carbohydrate per 24 hours. Although there had been no convulsions since May 24 the patient had been apathetic, incontinent, with hyperactive reflexes and a peculiar muscular rigidity associated with carpal spasm suggestive of tetany. This latter phenomenon had been noted before the operation but it had never been associated with an abnormally low blood calcium. The patient now developed an extreme mental confusion. On June 7 a note was made that the electrocardiographic record showed simple tachycardia. Roentgenogram showed normal sella. No changes in

The diagnosis of probable pancreatic tumor and the suggestion to perform the operation were made by Drs. Barr Alexander Scheraga, Parker Grove and others.

eye grounds. A previous examination of the visual fields gave normal findings. The blood pressure readings were always practically normal.

From this time on in spite of large amounts of carbohydrate the patient's condition became steadily worse. On June 5 the note was made that he was stuporous although responding slightly to cutaneous stimuli. There was slight cyanosis and the respirations were only 5 per minute. This recalled the periods of apnoea noticed at the operation. There had been no convulsions during the last few days but there was bilateral ankle clonus and slight rigidity of the left lower extremity. Because of a suggestion made in the report of Wilder et al that perhaps ether anaesthesia increased the blood sugar and in view of the temporary improvement noticed in our patient after the operation it was decided to subject him to an ether anaesthesia. At the beginning of the anaesthesia which was at the end of a 7 hour fast his blood sugar was 40 milligrams per cent. At the end of 50 minutes of anaesthesia his blood sugar was 45 milligrams per cent and 1 hour later it was 54 per cent. Three hours later however while still fasting the blood sugar had fallen to 22 milligrams per cent. During the next few days in spite of high carbohydrate feeding convulsions were frequent and the patient became increasingly worse. Tests to demonstrate insulin in the urine made by Dr Kuoymann of the department of biochemistry uniformly were negative, concentrated urine ammonium sulphate precipitation and alcoholic extraction being used.

Because it was felt that we had failed to find the active tumor responsible for the patient's condition especially in view of the results of the microscopic examination of the tumor which had been removed which will be described later the question of operating on the patient again was discussed. It was felt that unless another operation revealed an active tumor the patient would almost certainly die and that therefore another operation was plainly indicated. Accordingly on July 14, 1932 after the patient had been given 500 cubic centimeters of 20 per cent glucose intravenously the abdomen was reopened through an incision just to the left of the former incision and the pancreas was exposed again all along the anterior surface through the gastrohepatic omentum. Nothing resembling a tumor was found on the anterior surface. The tail was then mobilized and rotated forward. Within the substance of the tail but not visible on the surface a nodule was felt which was firmer than the rest of the pancreatic tissue. This could be felt only by palpation of the organ between the thumb and index finger. It was closer to the posterior than to the anterior surface. It was about 2 centimeters in long diameter. It was removed together with about 4 centimeters of the tail. In cutting through the nodule after its removal a rather homogeneous appearance was noted on cross section which made it seem certain that the nodule was composed of tumor tissue. The remainder of the organ was examined as

far toward the head as possible but no evidence of other tumors was found. Both adrenal glands were felt and found to be of normal size. The liver appeared to be normal but a small piece was removed for microscopic examination which was later found to be normal. The stump of the pancreas was closed over itself with chromic catgut. Immediately after the operation the blood sugar was 235 milligrams per cent. Another intravenous injection of 500 cubic centimeters 10 per cent glucose was given. Ten hours later the blood sugar was 218 milligrams per cent.

From then on the blood sugar remained normal or slightly above normal. On July 18 it was necessary to open the wound slightly to give access to about 50 cubic centimeters of pus which seemed to come from around the pancreas. Except for this complication the postoperative course was uneventful.

On August 9 a note by Dr A. B. Jones states that there is definite evidence of extrapyramidal tract degeneration.

The patient was discharged on September 14. He had shown very marked and steady improvement since the second operation and there had been no convulsions.

On October 17 he was readmitted to the hospital for observation. His sugar tolerance showed a slight tendency toward diabetes. There had been steady improvement in the patient's mentality and another examination by Miss Kendall at this time showed an intelligence quotient of 71 as compared with 60 on the preceding examination and a gain of 22 months in mental age. The patient was actively interested in everything going on around him and was able to defeat his father and his brother in chess. He was still unable to walk but a very definite improvement in muscle tonus was observed. Some of his difficulty in walking was undoubtedly due to the ankylosis of his hip joint which was noted in the first examination.

It is still uncertain how much additional improvement will occur in this patient's mentality. It seems probable that his central nervous system was more or less permanently damaged by allowing a condition of severe hypoglycemia to continue for too long a time.

Examination of the tumors. The two tumors removed from this patient were examined by Professor Bensley as well as by Dr O'Leary of our department of anatomy, a former pupil of Bensley's. An abstract of Dr O'Leary's report which includes both his and Dr Bensley's opinions follows.

The first tumor measured approximately 1.0 by 0.8 cubic centimeter and was composed of purple red friable tissue surrounding a heavily calcified core. Examination of the fresh material revealed a predominance of lymphocytes with numerous histiocytes, less numerous polymorphonuclears and eosinophiles. In histological section this mass resembled a calcified lymph node with hyalinization. Dr Bensley to whom the sections were sent to rule out

finally the presence of islet tissue felt that the specimen was a badly sclerosed lymphatic gland with a considerable amount of active reticular tissue proliferation. However it was removed from the substance of the pancreas and its great similarity to the pocket of tissue found in the capsule of the second tumor both in gross and microscopic appearance suggests the possibility that it might at one time have been an active tumor which became atrophied and was completely replaced when the present tumor arose. Supporting this possibility is the extension over a period of 3 years and the finding of a relatively young tumor mass at the last operation.

"The second tumor consisted of an ovoid mass 2.0 by 1.4 by 1.2 cubic centimeters, of firm elastic consistency. No hemorrhagic or necrotic areas were visible but embedded in the capsule was a single nodule of friable purple red tissue, 3 millimeters in diameter. This nodule consisted chiefly of lymphocytes with numerous macrophages and fibroblasts, less numerous polymorphonuclears and eosinophiles. It resembled in structure the first tumor which was removed from the same patient. As the result of an extensive study of the whole tumor after the use of various fixing agents and stains Dr. O'Leary summarizes his examination as follows: "the findings support the conclusion that the tumor removed was an adenoma of the islet type, cytologically very similar to those previously studied by Bensley and others but due to its size and excellent accommodation of tumor growth to vascular supply it was capable of producing relatively more of the hypoglycemic hormone than the previous tumors studied at this institution. In making this diagnosis, questionable evidence of malignancy has been discounted. The deviation of the majority of tumor cells from the beta type gives further affirmation to the dysinsulinism hypothesis.

The detailed report of the second tumor follows:

"When cut it appeared homogeneous throughout, save for strands of fibrous tissue traversing it. No hemorrhagic or necrotic areas were visible. Embedded in the capsule, however, was a single nodule of friable tissue purple red in color and 3 millimeters in diameter. This was dissected free and placed in Ringer's fluid for examination in the fresh. A sagittal block, including tumor tissue and adherent pancreas, was fixed immediately in formal chrome sublimate. Successive slices toward one surface were fixed in aqueous and acetic chrome sublimate. Altmann's and Bouin's fluids and formal absolute alcohol (the latter for micro-incineration). At the same time small bits were preserved in Ringer's fluid and in 0.1 and 0.05 per cent neutral red (Gruebner No. 0530) in normal saline. These bits provided material for the examination of fresh tissue. The remainder of the tumor was set aside for physiological assay.

"The bits of tissue for fresh examination teased with difficulty. Cells did not float free as in the Womack et al. and Carr et al. tumors previously

studied by R. R. Bensley. Even so, groups of cylindrical and polyhedral cells having clear nuclei, prominent nucleoli, their cytoplasm occupied by a haze of tiny granules, could be easily differentiated. To one familiar with the appearance of living islet cells of the pancreas this evidence was almost conclusive that the parenchyma of the tumor consisted of cells closely allied to this type. Prominent canals of Holmgren and refractile droplets could also be distinguished in some of the cells. In the material immersed in neutral red, the granules of but occasional cells colored the characteristic brick red that identifies beta islet cells. That this was not due to mechanical factors is illustrated by the occurrence of these cells among groups of cells whose granules remained uncolored. As compared with the Womack et al. and Carr et al. tumors, the cells whose granules colored by neutral red appeared to be significantly less numerous.

The reddish friable mass removed from one wall of the tumor had a cell content identical with that observed in a preceding mass removed from the pancreas of the same patient. It consisted predominantly of lymphocytes with numerous macrophages and fibroblasts, less numerous polymorphonuclears and eosinophiles. The possible significance of this finding will be discussed later.

"The fixed tissue was sectioned in paraffin at 4/8. The slice through the center of the tumor (formal chrome sublimate fixation) well illustrated the condition that maintained in all but isolated portions of the tumor. Sections from this and other blocks were colored by Mallory's triple stain, the Heldenbain azocarmine modification of the same, Bensley's and Bowie's neutral stains, hematoxylin and eosin and Delafield's hematoxylin followed by Giemsa's eosin azure. The neutral dyes of Bensley and Bowie, which facilitate the identification of cell types in islet tissue, and the azocarmine modification of Mallory's connective tissue stain proved to be the most useful.

"When a Mallory slide of the central block was examined it immediately became apparent that the major portion of the tissue closely resembled the beginning tumor stage (classification by Bensley, Womack et al.) of islet cell adenomata, and was remarkably similar to Robinson's description of the condition that prevailed in a tumor of the same type reported by Howland et al. It has a well developed stroma of collagenic connective tissue. Capillaries which issued from the arteries of this framework, carrying with them occasional collagenic fibrils, imperfectly divided the parenchyma into lobules and sinuous cords of epithelioid cells, two to several cell layers in thickness. Figures 6 and 7 illustrate this condition. There was in addition a dense central core of connective tissue and several lesser ones. These contained, besides arteries and veins, ducts of medium to small size and islets of tumor tissue. In the more superficial portions of the fixed material (aqueous and acetic chrome sublimate blocks) the connective tissue was richer in areas than in the

central block but as elsewhere no hyalinization had occurred. Surrounding the tumor was a broken capsule.

Ducts were not of frequent occurrence throughout the tumor. In the central block medium to small sized ones were found in the accumulations of connective tissue and at the surface of the tumor approximating the pancreas. From the connective tissue accumulations the ducts, as well as tongues of islet tissue might be seen to project into the surrounding parenchyma. Figure 8 is a photomicrograph showing the close approximation of duct and islet tissue in the vicinity of the central core. Figure 9 is a higher magnification of the same area. In the region adjacent to the pancreas (central block formal chrome sublimate) the connective tissue partition separating pancreas and tumor was broken by the egress of the ducts. The ducts in this area were differentiating into both islet and acinar cells. All the stages in the differentiation of acinar tissue were there to be observed. In the more superficial blocks of the tumor the capsule between pancreas and tumor was broken and normal pancreas graded into an area of regenerating (?) pancreas, this in turn into tumor. In these blocks ducts were much more numerous throughout the parenchyma and stages in their differentiation into islet cells were apparent.

"The parenchymatous cells of the tumor could be readily recognized as closely akin to the islet variety. Their shape variations were similar they were however most frequently larger in size as compared to normal control islets of the same section. The cytoplasmic granules of occasional cells gave staining reactions identical with those of the beta variety of islet cells. More often in these cells the granules were packed uniformly with the exception of the area occupied by the canals of Holmgren, but in some they appeared to be concentrated at the capillary pole. The cytoplasmic granules of the predominant majority of the tumor cells (henceforth called tumor cells to differentiate them from the beta cells of the tumor) stained differently but differentiation is necessary to explain the effect of coloring with neutral dyes. With Bowie's stain (formol chrome sublimate fixation) scarcely differentiated in absolute alcohol the beta cell granules stained deep blue the tumor cell granules lilac. Slightly better differentiated, the beta cell granules were a lesser blue, the tumor cell granules pink. This transition in colors due to different degrees of differentiation was not so noticeable with Bensley's neutral gentian and here the beta cell granules stained deep purple the tumor cell granules a lighter purple. Tumor cell granules were less closely packed in the cytoplasm the canals of Holmgren could not always be distinguished, and the small vacuoles occasionally seen in the cytoplasm of beta cells were lacking. Only one cell was observed in the tumor whose granules gave the staining reactions of those characteristic of the normal alpha cells of the islets of Langerhans.

Cytoplasmic inclusions of varying shape but identical staining reactions were observed in tumor islet cells. Presumably these were identical with the chromophile material described by Bensley as occurring in the islet cells of all the tumors that he studied. They might be plastered on the outer surface of the nucleus (sickle thickening of Bensley) or occur as discrete bodies in the cytoplasmic mass. The latter were round or spiroidal in appearance. Observed in a mitotically active cell they colored the same as the chromosome mass and could only be distinguished from it by a knowledge of their appearance in resting cells. Dr G. H. Scott informs me that in micro-incinerated sections these inclusions gave evidence of the presence of iron. They did not occur in the cytoplasm of the cells which contained degenerating nuclei. Several typical ones are illustrated in the accompanying photomicrograph Figure 10.

About the margins of the tumor nuclear pyknosis was to be observed. Other evidence of nuclear degeneration also occurred in the body of the tumor. Single cells or patches might be thus affected. Significant of this change was the appearance of clumps of chromatin within the nucleus. All stages between this and complete pyknosis were found. The cytoplasm of cells whose nuclei were thus affected became basophilic and discrete cytoplasmic granules could no longer be distinguished. Cells with hyperchromatic nuclei and those with mitotic figures were infrequently met with. In the cytoplasm of the latter the specific granules of tumor cells though they were reduced in number could be distinguished. Mitotic figures were not observed in beta cells of the tumor.

"The tumor parenchyma gave a negative Masson reaction for argentaffine cells. After 24 hours staining of the granules of histocytes could be observed but the islet cells were free from silver deposit. A control slide of Bouin's fixed intestine showed excellent argentaffine cells.

Insulin assay of second tumor (Dr. Aschmann). A portion of the tumor weighing 0.582 gram was treated according to the method which was found by Beat and Jephcott to give the maximum yields of insulin.

The extract was made up to 25 cubic centimeters in a volumetric flask and 10 cubic centimeters were injected into the marginal ear vein of a rabbit. Blood samples taken at various intervals gave the following results:

	Milligram per cent
Initial blood sugar	114
1/4 hour	92
1 hour	54
2 hours	52

Calculated by the method of Freudenburg the injected extract contained approximately 0.9 rabbit units of insulin.

A second rabbit was given 12 cubic centimeters of

the extract intraperitoneally. The blood sugar values were as follows:

	Milligrams per cent
Initial blood sugar	117
1 hour	86
2 hours	82
3 hours	46

3½ hours. Convulsions appeared that were relieved by glucose. The tissue analysed therefore contained approximately 40 rabbit units of insulin per gram of tissue. This is 10 times the amount of insulin found in the carcinoma of the islets in the case of Wilder, Allan, Power and Robertson.

This last case not only differs from any of those previously reported in that two tumors were present for the removal of which two operations were performed but there were several other unique features. For example this is the first case in which a tumor was removed which was embedded in the substance of the organ and detected only by palpation instead of by vision. It happened that the second tumor in this case could be found only by palpation. Again it seems surprising that in spite of the evidence of marked activity of this tumor no insulin could be demonstrated in the urine. This is perhaps the more astonishing since the assay of the tumor tissue revealed as much as 4 rabbit units of insulin per gram of tumor tissue, ten times as much as the amount found in the carcinoma of the islets reported by Wilder, Allan, Power and Robertson. Finally also it seems possible that some of the changes in the central nervous system in this case are of a permanent nature which may have resulted from allowing the severe hypoglycæmia to continue for too long a time, or perhaps they may be the result of hæmorrhages which are known to occur sometimes in of severe hypoglycæmia.

Including one case mentioned by Cushing as having been operated on at the Peter Bent Brigham Hospital but concerning which no details have been presented, this last case of ours is the fifth one from which a tumor has been successfully removed. Of these 5 cases 3 have been at the Barnes Hospital. It is an interesting fact that in the 4 cases about which the details have been published there has been no mortality. The absence of mortality and the uniformly dramatic nature of

the recoveries constitute an effective plea for more prompt surgical exploration in cases of hypoglycæmia of unexplained origin.

Unfortunately the diagnosis of the presence of an islet tumor is by no means easy. The recognition of a state of chronic hypoglycæmia even with the characteristic symptoms of the condition is not sufficient evidence in itself upon which to make a diagnosis of an islet tumor. Thus for example, other conditions have been found to be associated with the hypoglycæmic state. Phillips, in 1931, reported a case presenting symptoms of severe hypoglycæmia even with loss of consciousness. One determination of the blood sugar was as low as 25. At autopsy in addition to a sub-acute glomerular nephritis the islands of Langerhans were found to be markedly hypertrophied (242 to 328 microns as compared with the normal figures given by MacCallum of 146 to 157 microns). It is well known that disturbances of the adrenal glands may be associated with hypoglycæmia. There are now on record many observations showing that the blood sugar is lowered in Addison's disease and Anderson has reported a case in which there were pronounced symptoms of hypoglycæmia associated with a carcinoma of one adrenal gland. Again also the condition of hypoglycæmia is sometimes associated with certain tumors of the pituitary especially those which arise in the chromophobe cells which manifest adipose-genital symptoms of hypopituitarism. The literature on the association of pituitary lesions with hypoglycæmia is extensively reviewed in Sigwald's monograph. Various diseases of the liver such as primary carcinoma (5, 19), neoplasms, hæmangiohepatitis (6) and phosphorus poisoning as well as such a condition as scleroderma (4) are known to be associated with hypoglycæmia. Again other cases, especially in children have been noted in which a clinical picture closely resembling that of an islet tumor has been present but has disappeared spontaneously. Several such cases have been observed at the St. Louis Children's Hospital. For example

M. R., aged 2 years, had been caught by his mother stealing jam and jelly from her cupboard. The small boy was disciplined and the desired sweets were moved to a more secure place which was inac-

cessible to the pillering fingers. On the morning of the second day after the event his mother found it difficult to arouse him. He was brought to the Children's Hospital (September 3, 1931) where he was found to be in coma, with vomiting and acidosis. His blood sugar at the time was only 30 milligrams per cent. He was revived immediately by an intravenous injection of glucose. A sugar tolerance determination on September 5 showed

Fasting	077
3/4 hour	112
1 hour	104
2 hours	109
3 hours	090

Although observed repeatedly since his discharge he has been entirely normal. An operation on his pancreas at the time would have been ill advised. But yet one wonders what the future may show in regard to this child.

It is therefore apparent that the diagnosis of a state of spontaneous hypoglycemia does not in itself establish the diagnosis of an islet tumor. Moreover it will not always be easy for the surgeon to recognize the tumor even when present. If for example it should happen to be embedded in the substance of the pancreas its recognition might be impossible by any justifiable means. Again our last case complicates the situation still more because of the demonstration of more than one tumor a feature which adds an aspect of a possible therapeutic incompleteness if only one tumor has been found and removed. Finally also it would seem now as if sometimes adenomata are present which are inactive. However if an adenoma is found in a patient who has hypoglycemia the chances are very great that the removal of the adenoma will be followed by a marked improvement in the patient's condition.

Several failures to find a tumor at operation in clinically typical cases have now been recorded. In some of these cases attempts to correct the hypothetical condition of hyperinsulinism have been made by the removal of a large part of the pancreas. Such attempts have been made by the Finneys, by Holman and by Allan Boeck and Judd. The results in these cases have been disappointing. Perhaps an active tumor was overlooked and allowed to remain. Moreover it is hardly to be expected that the removal of anything less than nearly all of the pancreas would accomplish a desired result in correcting the

hypoglycemia unless by the removal of a part of the organ an active tumor was inadvertently extirpated. Recently however, Seale Harris has informed us in a letter of a case of "narcolepsy" that was operated upon by Dr. Adrian Taylor for me and the patient was cured clinically by the resection of about half the body and all the tail of the pancreas except the portion attached to the splenic vessels."

Note.—Since the preparation of this manuscript information has reached us that 2 additional cases of islet tumor have been successfully operated upon: one by Schmidt at the University of Wisconsin Hospital and one by Ross and Tomach at the Cleveland City Hospital. These 2 cases bring the number of the total of successful cases of removal of an adenoma to 7, with no reported mortality.

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STUDIES ON TUMOR METASTASIS

I. DISTRIBUTION OF METASTASES IN CARCINOMA OF THE CERVIX UTERI

SHEILDS WARREN AND BOWEN

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THE distribution of metastases has been studied in a series of 1059 autopsies on cases of malignant disease taken from the files of the Huntington Memorial Hospital from 1914 to date from the Department of Pathology of the Harvard Medical School from 1920 to date from the House of the Good Samaritan from 1920 to date from the New England Deaconess and Palmer Memorial Hospitals from 1928 to date and from the Pondville Hospital from 1928 to date

Only those autopsy protocols were utilized which afforded a satisfactory gross description and at least a fair clinical history. No case was included without review of the microscopic slides. For the statistical compilation of much of the data which was facilitated by the use of the punch card system. I am indebted to Dr Herbert L. Lombard, director of the Division of Adult Hygiene of the Massachusetts State Department of Public Health, and his assistants.

TABLE I—TYPES OF TREATMENT OF 132 CASES OF CARCINOMA OF CERVIX UTERI AS DETERMINED AT AUTOPSY

Type	Number	No. of patients treated	Operation	Radon	X-ray	Combined	Autopsy total distant, %
Epidermoid I		6	9	9		3	3
Epidermoid II	66		7	20		7	6
Epidermoid III	27	3				6	
Epidermoid not stated							3
Adeno-sarcoma	1						
Adenocarcinoma				7			9

TABLE II—DISTRIBUTION OF METASTASES

Type	Number	No. metastases		Metastases to				
		Number	Per cent	Regional nodes	Distant nodes	Lungs	Liver	Bone
Epidermoid I	5	5	100		7			
Epidermoid II	66	77	116	46	3	8	1	3
Epidermoid III		3	4	7	7	6	9	
Epidermoid not stated		4	100					
Adeno-sarcoma	1			3				
Adenocarcinoma			9	6	6			



Fig. 1. Graph showing percentage of distribution of metastases.

In this series of 1,059 cases are included not only so called active cases of cancer but a large number of terminal care cases as well. Many of the patients were treated others were untreated so an opportunity was afforded to study the behavior of untreated cancer as well as the treated forms of the disease.

Among this group were 132 cases of carcinoma of the cervix uteri.

In Table I is shown the distribution of these cases by histological class and the type of treatment given them. The cases which had no palliative treatment represent those coming to the hospital with far advanced disease or those who for religious or other reasons refused treatment of any sort. Under the heading of palliative treatment are grouped those cases in which the patients received small doses of deep X-ray colostomy for intestinal obstruction due to the presence of the tumor or other treatment instituted only with the idea of symptomatic relief and not expected to lead to cure or to appreciable amelioration of the disease. It is rather striking evidence of the delay in seeking treatment that 23 of these patients were found 17 per cent of the total.

Of course many additional patients given intensive treatment had well advanced growths when treated. Thus Leland found among 711 traced cases of cancer of the cervix treated with radium at the Huntington Hospital that only about 10 per cent fell in Class A and

Class B the 2 reasonably favorable for treatment. The table reflects the predominant use of radiation for cancer of the cervix in this vicinity.

Under the heading 'combined treatment' are included those cases in which the patients received radon and X-ray treatment or radon application operation and X-ray treatment. There are 32 in this group. Two cases received X-ray therapy only.

Of considerable interest is the variation in the total duration of the various forms of cervical cancers. Thus the average duration of the low grade epidermoid carcinomas (2.3 years) is twice that of the high grade and half again that of the cases of medium malignancy. It must be emphasized of course that these cases are all autopsies and, therefore represent failures in treatment.

Evidence of the close correlation between the histological grade of the tumor and the distribution of metastases is further strengthened by the present study (Table II). One hundred and two of these 132 cases were pre-

TABLE III—DEGREE OF MALIGNANCY AND NUMBER OF SITES OF METASTASES

Grade	Cases	Number of sites of metastases
Epidermoid I	23	10
Epidermoid II	66	124
Epidermoid III	31	68
Grade not stated	4	0
Adeno-sarcoma	5	10
Adenocarcinoma	11	22

TABLE IV.—SITES OF METASTASES

Type		Regional nodes	Distant nodes	Adrenal	Bladder	Bone	Brain	Colon	Endometrium	Heart	Kidney	Liver	Lung	Ovary	Pancreas	Peritoneum	Pituitary	Spleen	Stomach	Thyroid
Epidermoid I	Before treatment	7																		
	After treatment	3	3																	
Epidermoid II	Before treatment												4							
	After treatment												4			3				
Epidermoid III	Before treatment											8	3							
	After treatment	3	5										4							
Adeno carcinomas	Before treatment																			
	After treatment	3																		
Mesodermomas	Before treatment																			
	After treatment	3														3				
Total	Before treatment	48	36	3		3							30			3				
	After treatment	46	37									1	10			8				

vously reported (2) with particular attention to the relation of grading to power of metastasis.

These consistent results are due in part to the fact that the estimation of the grade of malignancy in an autopsy is not restricted to a single small biopsy but an adequate amount of tissue is available for examination. In this way a far more accurate determination of the grade is possible. Where there is marked variation in the histological appearance of a given tumor the less differentiated two-fifths of the portion studied has been used to determine the grade.

Too much stress can not be laid on the point that histological grading is of but little value in estimating individual prognosis. Here such factors as the extent of the local lesion, the presence of metastases, the age of the patient, the type of treatment utilized, must be given due weight. However histological grading is of great value in determining the radiosensitivity of the tumor and in determining whether or not the tumor is likely to metastasize.

In this connection it might be well to emphasize that there is much confusion between

radiosensitivity and what we might term radio-curability. In general the more rapidly growing more anaplastic, more malignant tumors are sensitive to radiation and not infrequently the local growth is destroyed by the treatment. However by virtue of their tendency to wide and early metastasis and deep local infiltration in the long run these highly malignant tumors very frequently prove as unsatisfactory when treated by radium as by any other means. The difficulty however lies not in the failure of radiation to affect these radiosensitive tumors but rather in the failure of the field of effective radiation to include all of the malignant cells.

In the present paper we are chiefly concerned with the distribution of metastases. This distribution is summarized in Table II and the close relationship between power of metastasis and histological grade of the tumor is brought out with extraordinary clarity. The percentage of variation in involvement of regional and distant lymph nodes and other organs by the different grades of tumors is shown in the figure, which presents graphically a portion of the material in Table II.

There is also close parallelism between the degree of malignancy and the total number of sites¹ of metastasis of the tumors of a given grade. This is brought out in Table III.

Thus the highly malignant epidermoid carcinomata average over three different sites of metastasis apiece whereas those of low malignancy average less than one apiece.

In grade III epidermoid carcinoma such unusual sites as the heart, spleen, kidney and thyroid have shown metastatic involvement.

Metastasis to bone is unusual in cervical cancers but in this series it occurred five times twice in grade III tumors and three times in grade II. The metastases were all of the osteoclastic type.

A given group of nodes, as the sacral, is considered as a single site even though several nodes may be involved.

Table IV gives the detailed sites of metastases of the various types of cancers together with an attempt to differentiate those metastases present before and those after treatment.

By careful study of the clinical record combined with study of the pathological processes themselves I have attempted roughly to estimate the time at which various metastases appear. Eighty per cent of those occurring after treatment appeared within 1 year. Of course, the length of life after treatment in most cases was short.

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THE FATE OF THE SIDETRACKED LOOP OF ILEUM FOLLOWING LATERAL ANASTOMOSIS FOR COMPLETE BENIGN OBSTRUCTION

A CLINICAL EXPERIMENTAL STUDY¹

C. E. HOLM, M.D., M.M.Sc., ALLENTOWN, PENNSYLVANIA

FOLLOWING a simple lateral ileo-ileostomy or ileocolostomy for complete benign obstruction of the terminal ileum the loop of ileum between the anastomosis and the obstruction may give rise to serious trouble as evidenced by the following case reports reviewed at the suggestion of Dr W. L. Estes, Jr. made to me while serving as resident surgeon at St. Luke's Hospital Bethlehem Pennsylvania

CASE 1: F. B. male aged 13 years, was admitted to St. Luke's Hospital, June 11 1929. Three days before admission the patient was seized with acute appendicitis, and at operation—1 hour after admission—a gangrenous, perforated appendix was found within a large abscess walled off by intestinal coils. Appendectomy was done and the abdominal cavity drained. Convalescence was prolonged because of wound infection, but was otherwise uneventful. At a follow up examination on October 17 1929 the patient was in excellent health. He remained free from abdominal symptoms until April 5, 1930 when intestinal obstruction occurred. Following his readmission to the hospital on April 7 repeated enemata failed to give relief and an operation was performed 3 hours later. The terminal 3 feet of ileum was adherent to itself, to the cecum, and to the anterior abdominal wall. Adhesions were divided to release a 3 inch loop of strangulated but viable ileum. Inasmuch as adhesions threatened future strangulation, a lateral anastomosis was established between the transverse colon and the ileum at a point 3 feet proximal to the cecum.

Throughout the convalescent period the patient had a good appetite and his general condition was excellent. A mild, painless diarrhea with considerable borborygmus and moderate distention of the lower abdomen developed 1 week before his discharge on April 22 continued in a mild form until May 4 when the diarrhea became severe, and vomiting occurred 3 days later. These symptoms became progressively worse and at admission to the hospital on May 9 the patient was found to be undernourished, dehydrated, drowsy and very toxic. The abdomen was moderately distended and generally tender but there was neither rigidity nor palpable mass. At operation the following morning the terminal 3 feet of ileum sidetracked on April 7 was found elongated to 7 feet, greatly dilated acutely inflamed and ulcerated, with the distal 1 foot completely obstructed in a mass of adhesions. The

meso-ileum contained many lymph nodes varying in size from a pea to a walnut. The colon was collapsed proximal and distal to the anastomosis. The sidetracked loop was resected, from the anastomosis to the cecum. During the manipulations of resection, several ulcerations of the loop perforated. The abdominal cavity was drained. A serious wound infection and a continuance of the pre-operative debility prolonged the convalescence. A mild diarrhea persisted throughout the patient's stay in the hospital and continued for several months after his discharge. Recuperation was slow for several months following his return home, but at the last follow-up examination in May 1931, he had gained 25 pounds in weight and his general health was excellent.

CASE 2: S. D. a boy of 16 years, was admitted to the hospital November 18 1928 with symptoms and signs of acute intestinal obstruction of 3 days duration. At operation several loops of terminal ileum were found matted together and adherent to the lateral wall of the pelvis, around a gangrenous Meckel's diverticulum. The ileum was completely obstructed at a point near the cecum. The involved loops of ileum were resected, following which a lateral anastomosis was performed between the ascending colon and the ileum 8 inches proximal to the resection. The 8 inch limb of ileum distal to the anastomosis was placed over a large defect in the posterior parietal peritoneum. The abdomen was closed with drainage. Ten days after operation the patient became slightly distended, and began having mild attacks of visible peristalsis which recurred during the remainder of his stay in the hospital. His general condition was good. After going home on December 7, 1928 visible peristalsis recurred with increasing frequency and was associated with marked borborygmus and pain. He had from two to six loose bowel movements daily. His symptoms becoming progressively worse he was readmitted on January 26 1929, and was operated upon 3 days later. The 8 inches of blind ileum distal to the anastomosis performed the previous November had become greatly elongated and distended and it filled the lower half of the abdominal cavity. It was coiled upon itself, with dense adhesions to the cecum and pelvic wall. The blind end of the ileum was partially freed from adhesions when the patient's general condition became too serious to permit resection and the operation was hastily terminated by performing a lateral ileo-ileostomy between a point near the end of the blind limb and an area immediately distal to the former ileocolostomy. Recovery was prompt and the patient was discharged on February 9.

¹From the Graduate School of Medicine and the Laboratory of Research Surgery, University of Pennsylvania, Philadelphia, and St. Luke's Hospital, Bethlehem, Pennsylvania.



Fig. 1



Fig. 2



Fig. 3

Fig. 1 Roentgenographic evidence of a dilated intestinal loop noted 7 weeks following lateral anastomosis between ileum and colon.

Fig. 2 Photograph showing dilatation and elongation of sidetracked ileal loop following the operation of lateral

ileocolostomy for the relief of complete obstruction of terminal ileum.

Fig. 3 Diagram explaining photograph in Figure 2 A, Anastomosis C colon I ileum O obstruction SL, sidetracked loop

At a follow-up examination on September 21 1929 the patient was much underweight due to a severe diarrhea of 4 months duration. There had been occasional attacks of distention borborygmus and painful peristalsis. He was placed on a strict diet and on January 2 1930 was greatly improved although abdominal distention and a mild diarrhea had persisted. His appetite had been good through out.

The patient was readmitted on January 7 1930 during an aggravation of the abdominal symptoms and he was operated on 3 days later. The lower two-thirds of the abdominal cavity was filled with the further elongated and dilated blind loop of terminal ileum. Proximal to the ileocolostomy the ileum seemed normal. The blind loop of ileum was freed of adhesions and resected at a point close to the ileocolostomy and the sigmoid was sutured over the denuded areas. The patient was discharged on January 28 greatly improved although he had a mild diarrhea. The diarrhea persisted for several weeks after his return home. At the final follow-up examination on May 8 1931 the patient was in excellent health.

A search of the literature on intestinal obstruction disclosed only an occasional clinical reference to complications occurring in the sidetracked loop of ileum following a lateral anastomosis for complete obstruction which necessitated secondary operation and resection, and failed to reveal reports of experimental work on this problem. In order to determine the fate of the sidetracked loop after lateral ileo-ileostomy or ileocolostomy for an induced, complete and permanent obstruction of the terminal ileum 7 dogs were operated upon. After operation all of the dogs were fed a liquid diet for 4 days a soft diet for 3 to 4 weeks and thereafter a general diet. Fluoroscopic studies of the intestinal tract were made on 5 dogs several weeks after operation to ascertain without sacrificing the animals if dilatation of the sidetracked loops had occurred.

THE FATE OF THE SIDETRACKED LOOP OF ILEUM FOLLOWING LATERAL ANASTOMOSIS FOR COMPLETE, BENIGN OBSTRUCTION

A CLINICAL EXPERIMENTAL STUDY¹

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CASE 1: F. B. male, aged 12 years, was admitted to St. Luke's Hospital, June 11, 1920. Three days before admission the patient was seized with acute appendicitis, and at operation—1 hour after admission—a gangrenous, perforated appendix was found within a large abscess walled off by intestinal coils. Appendectomy was done and the abdominal cavity drained. Convalescence was prolonged because of wound infection, but was otherwise uneventful. At a follow up examination on October 17, 1920, the patient was in excellent health. He remained free from abdominal symptoms until April 5, 1930 when intestinal obstruction occurred. Following his readmission to the hospital on April 7 repeated enemas failed to give relief and an operation was performed 3 hours later. The terminal 3 feet of ileum was adherent to itself, to the cecum, and to the anterior abdominal wall. Adhesions were divided to release a 3 inch loop of strangulated but viable ileum. Inasmuch as adhesions threatened future strangulation a lateral anastomosis was established between the transverse colon and the ileum at a point 3 feet proximal to the cecum.

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meso-ileum contained many lymph nodes varying in size from a pea to a walnut. The colon was collapsed proximal and distal to the anastomosis. The sidetracked loop was resected, from the anastomosis to the cecum. During the manipulations of resection several ulcerations of the loop perforated. The abdominal cavity was drained. A serious wound infection and a continuance of the preoperative debility prolonged the convalescence. A mild diarrhea persisted throughout the patient's stay in the hospital and continued for several months after his discharge. Recuperation was slow for several months following his return home but at the last follow-up examination in May 1931, he had gained 25 pounds in weight and his general health was excellent.

CASE 2: S. D., a boy of 16 years, was admitted to the hospital November 18, 1928 with symptoms and signs of acute intestinal obstruction of 2 days duration. At operation several loops of terminal ileum were found matted together and adherent to the lateral wall of the pelvis, around a gangrenous Meckel's diverticulum. The ileum was completely obstructed at a point near the cecum. The involved loops of ileum were resected, following which a lateral anastomosis was performed between the ascending colon, and the ileum 8 inches proximal to the resection. The 8 inch limb of ileum distal to the anastomosis was placed over a large defect in the posterior parietal peritoneum. The abdomen was closed with drainage. Ten days after operation the patient became slightly distended and began having mild attacks of visible peristalsis which recurred during the remainder of his stay in the hospital. His general condition was good. After going home on December 7, 1928 visible peristalsis recurred with increasing frequency and was associated with marked borborygmi and pain. He had from two to six loose bowel movements daily. His symptoms becoming progressively worse he was readmitted on January 16, 1929, and was operated upon 2 days later. The 8 inches of blind ileum distal to the anastomosis performed the previous November had become greatly elongated and distended, and it filled the lower half of the abdominal cavity. It was coiled upon itself, with dense adhesions to the cecum and pelvic wall. The blind end of the ileum was partially freed from adhesions when the patient's general condition became too serious to permit resection and the operation was hastily terminated by performing a lateral ileo-ileostomy between a point near the end of the blind limb and an area immediately distal to the former ileocolostomy. Recovery was prompt and the patient was discharged on February 9.

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Fig 7



Fig 8.

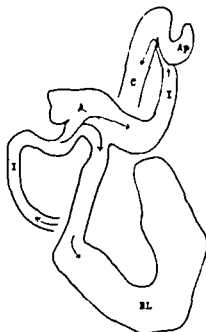


Fig 9

Fig 7. A dilated loop of intestine revealed by the X-ray.

Fig 8. Photograph showing an elongation and dilatation of blind limb of ileum distal to lateral ileo-ileostomy.

Fig 9. A graphic explanation of Figure 8. I, Anastomosis; Ap, appendix; C, colon; I, condition in ileum; BL, blind limb.

replaced by an ulcerative process made up mainly of plasma cells and fibroblasts and other areas of small round cell infiltration extending well into the muscular layer. Sections from a grossly normal portion of the sidetracked loop disclosed hypertrophy of the muscular layer and marked swelling of the mucosa with diffuse small round cell infiltration, lymphocytes and plasma cells predominating. Proximal to the anastomosis, the mucosa exhibited a mild degeneration and small round cell infiltration while the muscular coat was extremely thin with considerable round cell infiltration polymorphonuclear leucocytes in the minority. The macroscopically normal colon exhibited a complete loss of the staining quality of nuclei of mucosal cells. The liver showed widespread cloudy swelling and parenchymatous degeneration most pronounced around the central portion of the lobules. The kidney exhibited considerable vascular injection and severe glomerular and tubular degeneration with areas of small round cell interstitial infiltration.

Dog 499. An ileal obstruction was produced 6 inches from the cecum and a lateral ileo-ileostomy was established between points of the ileum 16 inches proximal 3 inches distal to the obstruction.

The immediate postoperative recovery was un-

important and the dog remained well and active for 5 weeks, when diarrhea developed and became increasingly more severe with slight distention and borborygmus. He lost weight but remained active and bright. Fluoroscopic examinations 6 and 7 weeks after operation demonstrated hyperactive peristalsis and a dilated loop of intestine. Roentgenogram is shown in Figure 4. Symptoms did not change during the following 7 weeks, except for lassitude and continued weight loss. The dog was sacrificed 14 weeks and 5 days after operation.

At autopsy the anastomosis was firmly healed around a stoma about 2 inches in length. The sidetracked loop of ileum had elongated from 16 inches to 38 inches and the terminal 8 to 9 inches had dilated to about four times the normal diameter. The walls were very thin in many areas, although the terminal 4 or 5 inches seemed to be hypertrophied. There was slight dilatation of the ileum for 1 inch beyond the obstruction. The colon and the ileum proximal to the anastomosis seemed normal. There were many large lymph nodes in the meso-ileum. The intestines were photographed (Figs 5 and 6), and then placed in formalin solution. Sections of normal appearing tissue were removed from the right lobe of the liver and the right kidney.

When the specimen was opened the terminal 5 inches of the dilated loop were found definitely hypertrophied with scattered ulcerations.

The 8 inches proximal to this were thin walled with many deep ulcerations. There were scattered ulcers in the remainder of the loop and distal to the obstruction. The colon and the remainder of the ileum seemed normal.

In a microscopical section taken from the hypertrophied portion of the dilated loop the muscle layer was greatly thickened with a degeneration of muscle fibers many of which were displaced by inflammatory tissue. The mucosa was markedly degenerated, necrosed, and infiltrated with inflammatory cells. The ileum 10 inches proximal to the anastomosis manifested slight degeneration of the mucosa and muscular layers. The liver exhibited widespread and intense fatty infiltration with pigmentation of the liver cells, most pronounced around the central veins. There was vascular congestion and some of the central veins had thickened walls, while others were occluded with blood cells under going organization. The kidney showed advanced tubular and moderate glomerular degeneration.

Dog 65. The operative procedures on this dog were designed to simulate those in clinical Case 2.

The ileum was severed transversely 6 inches from the ileocolic juncture and its ends were turned in. A lateral ileo-ileostomy was performed allowing the proximal end of the ileum to extend 8 inches beyond the anastomosis.

The immediate postoperative recovery was uneventful. Diarrhea developed in 3 weeks and became increasingly more severe. There was listless ness, slight distention and considerable weight loss at the end of 6 weeks. The fluoroscope demonstrated a dilated loop 6 weeks after operation. A roentgenogram was made (Fig. 7). The condition of the dog remained unchanged during the next 4 weeks and he was sacrificed 10 weeks and 3 days after operation. The appetite was well maintained throughout.

At autopsy, performed very soon after death there was no evidence of peritonitis, the anastomosis was well healed, and the stoma was 1½ inches in diameter. The blind limb of ileum had elongated from 8 to 16 inches and the terminal 8 inches had dilated to three times the normal caliber with the walls generally thin (Figs. 8 and 9). The lymph nodes in the meso-ileum were greatly enlarged. The section was removed and placed in formalin solution. Seemingly normal tissue was removed from the right lobe of the liver and from the right kidney.

When the specimen had been opened the terminal 4 inches of the dilated limb were found hypertrophied with many small ulcerations. The walls in the remainder of the loop were thin and ulcerated. There were scattered ulcerations in the ileum proximal to the anastomosis, between the anastomosis and the cecum, and in the colon.

Microscopically a section from a thin portion of the dilated limb manifested marked degeneration

and necrosis of the mucosa extending to the muscle layer. A section from a thick portion of the limb displayed degeneration and necrosis of the surface of the mucosa. Sections from normal appearing colon, showed small round cell infiltration and slight degeneration of the mucosa. The liver and the kidney exhibited the same type of widespread degenerative changes seen in the other dogs.

Dog 487. Obstruction was produced and an ileo-ileostomy was established as in dog 575. The immediate postoperative course was similar to those described in the protocols of the other dogs. Death occurred 6½ weeks after operation from general peritonitis, due to a perforation in the obstructed loop. Gross and microscopical findings were much the same as those described in the three protocols. The terminal 3 inches of the sidetracked loop were hypertrophied.

Dog 651. Operative procedures were the same as in dogs 575 and 487. Postoperative symptoms and physical findings were almost identical to those previously described. A dilated loop of intestine was observed fluoroscopically after a barium meal at the end of 5 weeks. The dog was sacrificed during the ninth week. Macroscopically and microscopically the findings were similar to those in the other dogs.

Dog 713. Obstruction and ileo-ileostomy was done as in dog 499. The postoperative course was practically the same as that of all the other dogs until death occurred 6 weeks after operation from general peritonitis resulting from a perforation in the obstructed loop. Gross and microscopic findings were similar to those found in the other dogs. The terminal 1½ inches of the obstructed loop was hypertrophied.

Dog 493. A lateral ileo-ileostomy was performed as in dog 657 leaving a blind limb 6 inches long. The postoperative course was about the same as that of the other animals. Fluoroscopic evidence of a dilated intestinal limb was seen at the end of 7 weeks. It was necessary to sacrifice the animal 13 weeks after operation because of extreme emaciation and debility. The terminal 5 inches of the enlarged blind limb were hypertrophied. Macroscopic and microscopic findings were similar to those observed in the other animals, but in all instances the degenerative changes were more advanced.

SUMMARY

In two clinical cases of complete obstruction in the terminal ileum resulting from adhesions, various types of lateral anastomoses were done without removal of the ileum between the anastomosis and the obstruction. Following the anastomoses the patients developed diarrhea, borborygmus, abdominal distention, marked weight loss and debility without impairment of appetite. In each

patient complete recovery followed resection of the sidetracked loop, which was greatly elongated, markedly dilated, and ulcerated.

An intestinal obstruction was produced in the terminal ileum in 7 dogs, following which various types of lateral anastomoses were done, allowing the sidetracked loops to remain. After operation all of the dogs developed diarrhoea, borborygmus, distention, weight loss and debility, but maintained a good appetite. Two dogs died from general peritonitis resulting from perforation of the sidetracked loop. Five dogs were sacrificed. In all 7 dogs the sidetracked loop was found markedly elongated, greatly dilated and ulcerated. Microscopic sections showed areas of deep and superficial ulceration in the dilated loops, superficial mucosal ulceration of the ileum and colon remote from the sidetracked loops, and widespread advanced degenerative changes in liver and kidney.

CLINICAL APPLICATION OF EXPERIMENT

The terminal ileum was selected for study in the experimental work because it is a common site for obstruction from adhesions as evidenced by the two clinical cases.

Photographs of roentgenograms and dilated sidetracked loops displayed on the abdomens of the dogs have been omitted in the abstracts of the four protocols because they were practically identical to those presented.

The more advanced liver and kidney changes in two dogs might have been due, in part, to the general peritonitis.

The superficial necrosis of the mucosa in the intestines remote from the sidetracked loop, indicated a general enterocolitis as the cause of the severe diarrhoea in all of the animals. It is assumed that a similar condition existed in the two clinical cases reported and was responsible for the diarrhoea which persisted throughout their illnesses and for several months after resection of the sidetracked loops.

The type of degenerative changes observed in the liver and kidney sections from the dogs probably were present in the 2 patients and might have been a factor in the toxicity which they displayed and the period of slow recuperation which followed resection.

The postoperative signs and symptoms occurring in all of the dogs were similar to those observed in the two patients prior to resection of the sidetracked loop.

Fluoroscopic and X-ray examination aid diagnosis in detecting elongation and dilatation of the sidetracked loop of ileum in patients who exhibit the symptoms and signs of the two clinical cases.

Surgeons generally recognize that it is not advisable to permit a blind limb to extend beyond a side-to-side anastomosis. In any lateral anastomosis for permanent, complete obstruction the sidetracked loop corresponds to a blind limb extending beyond the anastomosis.

CONCLUSIONS

1. The sidetracked ileal loop of a lateral ileo-ileostomy or ileocolostomy for complete benign obstruction of the terminal ileum is likely to become greatly elongated, dilated, and ulcerated. An enterocolitis with mucosal degeneration and degenerative lesions of the liver and kidneys will probably develop.

2. Whenever possible the sidetracked ileum should be resected at the time the lateral anastomosis is done.

3. If resection is inadvisable because of the condition of the patient, the lateral anastomosis should be done as near the obstruction as possible, and should be regarded only as a first stage operation, to be followed by a resection of the sidetracked loop of ileum at a more favorable time.

4. As an alternative procedure it is suggested that the ileum might be divided as close to the obstructive lesion as possible and be followed by an end-to-side anastomosis which eliminates a blind end.

LIGHT AND TAR CANCER

AN EXPERIMENTAL STUDY WITH A CRITICAL REVIEW OF THE LITERATURE ON LIGHT AS A CARCINOGENIC FACTOR

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PART I. EXPERIMENTAL STUDY

DESPITE the fact that the rôle of light in the genesis and development of cancer is of interest both experimentally and clinically, very little clear-cut experimental work has been done upon this subject. Part II of this paper, a critical review of the literature on light as a carcinogenic factor, emphasizes the necessity for well controlled experimental data. With the object of collecting such data, we attempted to determine the carcinogenic effect of tar applied to mice kept in an environment from which light was totally excluded.

Material and methods. In one corner of our animal room, a light proof chamber 18 by 15 by 12 feet was built, two sides of which were made up of the south and east walls of the animal room, and the other two sides of 0.5 inch fiber board (Masonite) that extended from floor to ceiling. There were three windows in the original wall space. Instead of walling in these windows, light traps were built about them so as to permit the entrance of air and to exclude light. The entrance to the room was through a light proof maze built of fiber board. All joints and crevices in the fiber board walls were made light proof by caulking. A 14 inch galvanized iron flue pipe painted black on the inside and furnished with light blocking baffles, entered through a light tight opening and led to an exhaust fan within the dark room. In this manner a constant stream of fresh air was kept moving from the windows out through the exhaust duct. In the room were two steam radiators, by means of which the temperature could be regulated. The room was furnished with racks for mice cages, a work bench provided with a ruby light, and storage places for animal food.¹ Tar

and various accessories. This room assured total darkness and an environment that was otherwise comparable to that in which mice live out their natural lives in the ordinary well constructed animal room. After the room was built, a set of highly sensitive photographic plates were exposed in it for 48 hours. When developed, these plates showed no evidence of being light struck.

The tar used in these experiments was distilled so that only the fraction coming off at 370 to 440 degrees C. was collected. This distillation² was so executed that this tar fraction (370 to 440 degrees C.) was not exposed to light during the process. The tar was then kept stored in the dark room, in light proof receptacles.

Three sets of mice were segregated for the experiment. (1) 125 male mice, approximately 3 months old, were set apart for tarring in the dark. (2) a similar group of 125 were set apart for tarring in the light, and (3) a similar group of 50 were kept as controls in the dark room. This last group was not tarred and was used merely as a check on living conditions in the dark. The experiment was not begun until the mice had been kept in the dark for 3 weeks.

After the elapse of this preliminary period the group of 125 mice kept in the dark were tarred as were the similar group kept in the light. After preliminary depilation with sodium sulphide, tar was applied between the scapulae once or twice a week until the animals died. A complete autopsy was performed on every mouse. All skin lesions and all suspicious visceral nodules were removed and examined in microscopic sections.

It was not until the experiment had run almost 4 months that we fully realized the advisability of using genetically bred mice. The comments of Little have much force, even

¹As an added precaution, the animal food (chiefly cracked corn) was kept in the dark room. The green stuff and bread and milk, which were necessary in the diet of the mice, could not be kept entirely unexposed to light.

²We are indebted to Messrs. D. Wilson and J. Kahlberg, of the Lacerte Gas Light Company of St. Louis, for their assistance and co-operation in performing our tar distillations.

though one may not be willing to subscribe unqualifiedly to his statement that "it is to day as careless to use unknown genetic material in experimental pathology as it is for a chemist to attempt to analyze substances using unknown rather than known reagents." After much soul searching we decided to present our data such as it was, rather than to start the long drawn out procedure of raising 300 genetically bred mice, and starting the experiment anew. We were emboldened in this position by the fact, as emphasized by Roffo, that in tar cancer, the receptivity or susceptibility varies not only in animals of different species and in animals of near relationship but even among animals of the same family. Moreover susceptibility varies in different anatomical sites of the same animal and possibly even in cells of the same anatomical site. Twort and Twort emphasize in particular the impossibility of establishing a standard value of the unit of carcinogenicity. Reinhard and Candee found that strains of mice with either a high or low incidence of spontaneous cancer responded similarly to tarring except that the latent period in the low incidence strain was 14 weeks longer than in the high. Parodi found also that individual susceptibility varied even in a strain of genetically bred mice. These several observations in addition to Roffo's testimony strengthened us in our determination to run the experiment through with ordinary laboratory mice.

GROUP I 125 MICE TARRED 23 TIMES DURING
A PERIOD OF RESIDENCE IN TOTAL DARK-
NESS OF 27 WEEKS

After living for 3 weeks in the dark the mice of this group were tarred with the high fraction tar distillate, already mentioned. The tar was applied to the interscapular region at the root of the neck over an area about 1.5 centimeters in diameter. At first these applications were made every third day but our tar proved to be so highly toxic that we varied the time interval between paintings to meet the problem of high death rate. The last animal in the group died 24 weeks after the first application of tar and during this period tar was applied 23 times. During the last 4 weeks

of the experiment no application of tar was made. In the early part of the experiment crust was removed as it formed at the site of application of the tar but since this seemed to favor toxic absorption of the tar we, later let the crust drop off spontaneously.

When an animal died a complete autopsy was performed, the tarred area was excised and paraffin sections of it prepared. From the outset we determined to call only those growths carcinomata in which we could demonstrate that the neoplastic epithelium infiltrated the subcutaneous muscle layers. It scarcely seems advisable in this report to go into the lengthy and intricate chapter of the essential histological criteria of tar cancer. Those who are interested will find the subject discussed by Woglom and by Seelig and Cooper. Here it suffices to say that intramuscular infiltration seemed to us to be of all others, the most satisfactory and reliable basis for the diagnosis of cancer. We avoid the use of the terms epithelioma and canceroid and, although in several of our mice (in the group kept in the dark and likewise in the group kept in the light), the cell morphology, growth, tinctorial reaction, and mitotic activity of the lesions, pointed indubitably to the diagnosis of cancer we did not record the tumor as such unless it infiltrated out of bounds into muscle tissue.

In Group I, thickening and keratosis of the skin was noticeable macroscopically 2 weeks after the first application of tar. At about 8 weeks after the first painting papillomata began to appear. Some of these growths which macroscopically appeared to be papillomata proved microscopically to be more on the order of keratotic warts. After 4 weeks of tarring 27 mice had died, a mortality rate of slightly over 20 per cent. Part of this high mortality rate (which was paralleled by the control group tarred in the light) was due to toxic effects of the tar and part of it to an epidemic of diarrhoea, which invaded the entire colony of laboratory at this time. Later our animals suffered from what seemed to be an epidemic form of pneumonia. However the death rate among the animals used in this experiment was not high enough to invalidate our final results.

Beginning with the eighth week papillomata were abundant and from then on these papillomata either showed a tendency to develop induration about the base, or to ulcerate. Some of them dropped off to be replaced by new papillomata.

By the end of the eighth week approximately 50 per cent of the animals had died by the end of the twelfth week, 70 per cent by the end of the twentieth week, 90 per cent. There were now 8 surviving animals which succumbed one by one, the last one dying 24 weeks after the beginning of tarring. An analysis of this mortality rate discloses that if we assume dogmatically, that we might expect carcinogenesis to develop about the tenth week then at this time 47 of our original group of 125 mice remained alive. Of these 47 mice that remained 11 mice developed carcinomata, conforming to the histological criteria already described. The tumors were all of the squamous cell type, and all of them presented histological evidences of very active growth (mitoses markedly anaplastic cells,—both with regard to size and shape of the cells and variations in tinctorial reaction—and very little evidence of keratinization or pearl formation).

Visceral metastases were found in only 2 of the 125 mice in Group I. These 2 animals showed squamous cell carcinomata of the lungs. In one mouse, a regional lymph node of the root of the neck showed a metastatic squamous cell carcinoma. (In the case of the lymph node, it was quite apparent that we were dealing with a metastatic focus but we are unwilling to dogmatize regarding the carcinomatous foci in the lung for we know of no reliable method of differentiating primary or spontaneous carcinomata of the lungs from secondary or metastatic foci).

The 11 mice that developed carcinomata died 110 116 125 136 139 146 147 150 153 155 and 157 days, respectively after the beginning of tarring. In view of the fact that our plan was to examine tissues only after the animals had lived out their lives and that we were unwilling to add the element of trauma, incident to performing a biopsy, we cannot furnish data regarding the earliest time at which the cancers were demonstrable. The

most that we can say is that 11 out of a series of 125 mice developed cancer (approximately 9 per cent) and that the average duration of life of these mice was 140 days after the beginning of tarring.

In Group I 2 mice developed growths that showed all the other characteristics of malignancy but that did not infiltrate muscle. We did not classify these tumors as malignant.

GROUP II 125 MICE, TARRIED 27 TIMES DURING A PERIOD OF RESIDENCE IN THE LIGHT OF 32 WEEKS

In this control group as in Group I, we found that owing to the toxicity of our tar we could not make the applications on fixed dates or at predetermined intervals. The last animal in this group died 32 weeks after tarring was begun and during this period, tar was applied 27 times. It will be noted, therefore that the length of the experiment was 5 weeks greater than that of Group I and that 4 more applications of tar were made. It scarcely seems warrantable from these facts to draw any specific conclusions regarding the influence of light on the general hygiene and duration of life of the animals or on the toxicity of tar.

In this group just as in Group I each animal was permitted to live out its life pathological examinations being made in every instance after death. Macroscopically no essential differences from Group I were apparent in this group with regard to crusty thickening of the skin, keratosis or development of papillomata. At the end of the sixteenth week the mortality rate was 85 per cent, as contrasted with 84 per cent in Group I by the end of the twentieth week the mortality was 90 per cent as contrasted with 88 per cent in Group I. The last animal died 228 days after the tarring was begun. A particularly interesting phase of the comparative mortality rate in the two groups is that the early mortality was much greater among the animals of Group I. For example at the end of 4 weeks the mortality rate in Group I was 23 per cent, whereas in Group II it was 9 per cent (see Table I).

The significance of this difference in mortality rate lies in the fact that a larger number

of mice in Group II received applications of tar over a longer period of time than in Group I. Despite this in Group II only 5 carcinomata developed as contrasted with 11 that developed in Group I. In all of the animals the tumors were of the same histological type as those in Group I and in one animal there developed a squamous cell carcinoma of the lung which we considered metastatic. In this group the first animal in which carcinoma was found died 161 days after painting began; the other 4 animals dying respectively 172, 194, 198 and 221 days after the beginning of painting. Compared with Group I these figures would seem to indicate a delayed effect but since we had no way of determining exactly when the cancers developed we do not feel warranted in stressing the time element.

In this group there were 3 mice with tumors that showed all the other characteristics of malignancy but that did not infiltrate muscle. We did not classify these tumors as carcinomata.

GROUP III 50 MICE UNTARRED KEPT IN THE DARK FOR 22 WEEKS

This group was used merely to check the effect of living conditions in the dark room. An unusually high mortality rate might have indicated that darkness alone exercises a marked constitutional effect on the animals. However, when the last of the tarred animals died in the dark, 21 of the original 50 of the untarred animals of Group III were still living. This represents a mortality rate of 58 per cent which is not abnormally high for a group of 50 mice over a period of 22 weeks. If we bear in mind the two epidemics already mentioned, it would seem therefore that complete darkness in itself does not influence the general condition nor the mortality rate of the mice to a degree that in any way affects the experiment.

CONCLUSIONS

1. The absence of light did not cause any physical compromise in a group of mice subjected to total darkness over a period of approximately 5 months.

2. White light is not a necessary factor in the development of tar cancer in mice, be-

TABLE I—MORTALITY RATES

	Group I Tarred in the dark	Group II Tarred in the light	Group III Not tarred in the dark
Number of mice	5	5	5
Duration of experiment	4 (weeks)	32 (weeks)	2 (weeks)
Number of litters	23	27	6
Number of carcinomata	1	5	0
Per cent of mice developing carcinomata	5.3	4	0
Number of metastases			0
Mortality per cent			
4th week	22.2	9.6	0.0
8th week	40.0	48.0	0.0
12th week	66.7	77.8	30
16th week	80.0	85.2	58
20th week	93.3	96.3	58.0
24th week	100.0	96.0	
28th week		98.4	
32nd week		100.0	

Experiment discontinued after 32nd week—4 per cent of animals still living and well.

cause in total darkness in the group of mice used in these experiments a larger number of tar cancers developed than developed in a similar group of mice that were tarred and kept in the light.

3. The comparatively larger number of carcinomata occurring in the mice kept in the dark is too small to warrant the conclusion that the absence of light in itself favors the development of tar cancer in mice.

4. These experiments do not eliminate the possibility that light may be a secondary factor in the genesis of experimental cancer. They furthermore do not warrant dogmatic and direct deductions applicable to human cancer.

PART II A CRITICAL REVIEW OF THE LITERATURE ON LIGHT AS A CARCINOGENIC FACTOR

Ten years before the beginning of the present century the Hamburg dermatologist Unna, made elaborate histological studies of the influence of light on the development of cancer. These studies were made in relation to the development of cancer in Xeroderma pigmentosum and in 'sailors skin' (a disease described originally by Unna). Unna

announced that light was the noxious agency in the production of these two special forms of cancer and that the histological changes to be noted in the precancerous skin lesions (capillary hyperemia, venous ectasis, hyperkeratosis, sclerosis of the skin surface and pigmentation) indicated endeavors on the part of the skin to neutralize the injurious influence of light. The pigmentation blocks all light and the hyperemia protects the deeper structures by cutting out the highly actinic blue rays (as does the photographer's ruby light). The hyperkeratosis, sclerosis and capillary atrophy of the papillary bodies operate not by arresting the light but rather by diminishing its influence on cutaneous tissues that are less sensitive drier harder more tendonous and callous.

Watkins-Pitchford in 1909 attempted to develop an all embracing theory that cancer whether of special sections of community life or of special parts of the body of the individual is caused by an illumination in excess of that which can be dealt with by the protective agencies of habit posture coverings and external pigmentation and in excess of that which may be controlled by the agencies of internal pigmentation and cell memory for former-environment that the generally increased liability of man as compared with the lower mammalia is chargeable against the comparative novelty of his attitude and almost complete loss of his hairy coat that the special liability of the white man, as compared with the black man is due to the loss of pigmentation and to his changed environment and finally that these liabilities do not show themselves in the individual as vague general and constitutional predisposition but are strictly confined to those parts of the body in which irradiation becomes excessive.

Watkins-Pitchford characterizes his thirty page prize essay as purely an induction from observation. It is all of this and nothing more. The author has assembled however a striking amount of comparative anatomical, physiological pathological and ethnological data in support of an hypothesis which he leaves unproved. Hoffman suggests that the high incidence of cancer among seamen

and fishermen may lend support to Watkins-Pitchford's hypothesis. This is possibly true but a great deal of support would be necessary in order to furnish essential strength to an hypothesis that makes light the agency in the causation of cancer.

Paul states that the most important cutaneous lesions in Australia (viewed from the standpoint of prevalence and destructive effects) are rodent ulcer and epithelioma." He believes that the most significant causative factors of these lesions are the actinic rays of light, and that the most significant inhibiting factor is the pigment deposit in the skin, particularly noted in the colored races occupying the tropical and subtropical countries. In these people the effect of sunlight is minimal despite the fact that exposure to it is most severe and long continued.

Paul believes that melanin stands as a skin sentinel protecting the underlying tissues from the baneful effects of sunlight. In the white races this pigment is confined for the most part, to the periphery of the cells of the basal layer of the epidermis and the lowermost stratum of the prickle cell layer while the pigment granules may also be found in the inter epithelial spaces and in the fusiform connective tissue cells of the papillary body. Paul quotes Macleod as authority for the statement that in the dark races pigment is to be found as high up as the transitional layers of the epidermis as well as in some of the connective tissue cells of the superficial portions of the corium.

Watkins-Pitchford and Paul are not the only authors who stress the possibility of making the actinic light rays responsible for skin cancer. Duhig also thinks that they are the sole factors responsible for that disease, though he admits that the evidence on which his belief rests is indirect. Duhig is pathologist to the Coast Hospitals Board and to the Brisbane Hospital, in Queensland Australia where he gathered the data on which he bases the following statements:

Cancer of the skin is four times more common in males than in females, and in those females affected, considerable periods of exposure to the strong sunlight of Queensland have been known to occur. Those males affected, almost invariably give a good

history of exposure. Also the disease is one preponderantly of life beyond the middle years—that is, the longer the exposure the greater the incidence while lack of exposure runs concurrent with the absence of the disease even in advanced life.

The disease occurs practically exclusively on those parts of the body constantly exposed to sunlight. In 3 cases only of nearly 500 investigated did cancer occur on habitually unexposed skin—once on the foot, probably as the result of trauma, once on the thigh for a similar reason, and once on the thoracic wall for no discoverable reason. The disease occurs preponderantly on the face, ears and neck, and on the back of the hands in only about 5 per cent of the cases. Cancer of the back of the neck is almost exclusively confined to males at present, though I would predict that as a result of the fashion of short hair and the very silly one of berets and cloche and similar brimless hats in summer affected by women in this country in an effort to keep up with the overseas magazine life, cancer of that part of the body will be later just as common among women as now amongst men.

It is strange that no direct evidence of an experimental kind is available as to the effect of sunlight on the human skin, though some little work has been done on the effect of the ultraviolet and of the spectrum. I do not know that it is necessary to prove experimentally the bad effect of direct sunlight on the human skin to me such work would only go to confirm my present opinion that *skin cancer is solely due to excessive exposure to sunlight*. It is commonly believed that only persons of ruddy complexions accompanied by russet or reddish hair are susceptible. After a long experience I would say that probably susceptibility is inversely proportional to abundance of skin pigment in a general way, but that a brunette complexion is not a safeguard. It is a very significant fact however that cancer of the skin does not occur in India, to any extent among the native races.

In an article on cancer in the negro Hoffman furnishes a veritable storehouse of information on the subject of cancer in the dark skinned races of the world. The data presented by Hoffman is so highly statistical and his reasoning so closely knit that an injustice would be done him by an attempt to abridge his article within short compass. He does however make categorical statements to the effect that (1) cancer mortality of the American negro tends more and more to approach that of the white population as the result of a persistent rise in the cancer death rate of the negro during the past 30 years, (2) negro women show a much greater liability than white women, to malignant and benign tumors of the generative organs and also of

the breast, (3) the prevailing rate of cancer of the skin is 3 times higher in whites than in negroes.

It is of course manifestly inadequate to select three terse statements such as the above from an essay packed with information but for our immediate inquiry it is sufficient to know that Hoffman is strongly inclined to believe that available statistics seem to support the opinion that the colored races are less liable to skin cancers because of the protective influence exercised by the pigment of the skin.

Heller in his study of cancer in tar and mineral oil workers in the United States found a very low incidence of the disease. In part he attributes this to the fact that the negro workers in this industry possess at least a partial immunity to skin cancer. This assumption carried with it of necessity the conclusion that the carcinogenic effect of tar is, in part at least, dependent upon the activating influence of light.¹

In the clinic of The Barnard Free Skin and Cancer Hospital of St. Louis we have made no special survey, but it is the unanimous opinion of all the workers in this institution that although breast and visceral cancer is very common in the negro strikingly few patients with skin cancer have been seen during the past 25 years.

Up to this point, we have considered only those investigators, who have contented themselves with formulating experimentally uncontrolled hypotheses regarding the influence of light on the development of cancer. It has, of course been recognized for years that the carcinogenicity of actinic rays could not be accepted on any other than experimental proof. Considering the importance of light as a possible factor in cancer one is struck by the scanty effort devoted to the experimental study of this topic.

Grynkrant makes a contribution which seems to have the flavor of research but which in reality is only a theory built up on an intricate bit of hypothetical reasoning involving exogenous and endogenous light rays (the latter corresponding to the so called mitogen

¹Heller does not furnish any grounds for believing that the negro enjoys any other special immunity not shared by white workers.

etic rays of Gurwitsch and a hypothetical *sensibilisateur* which permits the utilization of light and puts the cell nuclei in resonance with the wave length.

Bachem and Reed developed a method of measuring the transmission of light rays through tissues, thus facilitating the study of the problem of penetration. The method depended essentially on filtering the rays of a Kromayer lamp, an incandescent bulb and infra red radiation. These authors concluded from their studies that the visible and near infra red rays are strongly absorbed in the blood of the corium and subcutaneous layers that the infra red has very little penetrating power, not much of it going beyond the epidermis and that variation in percentage penetration is greater in the ultraviolet than in other portions of the spectrum. At 280 millimicrons absorption is marked in the corium and prickle cell layer. On both sides of the band near 300 and 250 millimicrons the penetration is greater, reaching the stratum malpighii and corium. From 250 millimicrons down the absorption is so complete as to prevent any radiation from reaching the living layers of the skin. These authors believe that the strata corneum and granulosum must play an important part in light protection in lower sensitive layers.

The lipids, and in particular cholesterol, have assumed an increasingly prominent rôle in the story of cancer genesis. Roffo, who has probably done the largest amount of work in this particular field, believes that the lipids exercise a strong influence in preparing the terrain for cancer growth. More than this, he correlated the greater frequency of cancer of those regions of skin exposed to light with the increased cholesterol content of the exposed areas. Rats exposed to the sun developed a larger percentage of cholesterol than did control animals. Roffo also reports observations to prove that in cancer and precancerous lesions there is an hypercholesteremia, with localization of cancer in the regions showing highest percentages of cholesterol. He believes that a relationship exists between the photoactivity of cholesterol and cell function, that sunlight serves to fix the cholesterol in the tissues, and that cholesterol then becomes an

organic accumulator of light. The cholesterol becomes photoactive as a result of oxidation by light, the intensity of the oxidation depending upon the length of irradiation. Irradiation produces molecular changes, the molecular weights varying according to the duration of radiation.

One hesitates to accept some of Roffo's conclusions regarding the specific agency of cholesterol in cancer, and this hesitancy becomes all the more pronounced if one believes with Bishop that "our knowledge of the factors that determine the level of the various lipid constituents in the blood in disease is pitifully meager. There is no evidence to support the suggestion of abnormal cholesterol conditions in association with cancer." Any one who carefully surveys the literature of tar cancer must be struck by the conflicting reports regarding the stimulating or inhibiting effect of lanolin, whether applied at the tarred site or remote to it. These conflicting reports incline one to be skeptical of Roffo's conclusions. Downes, in a study of 63 cases of malignant tumors, could find neither a constant relationship between the concentration of cholesterol in whole blood and plasma, nor any increase above normal of the blood cholesterol in the presence of cancer. Klaus reports a lowering of blood cholesterol in genital cancers in women. Thus, the reports vary all the way from hypocholesteremia to hypercholesteremia, rendering the topic one of utter scientific chaos.

Unfortunately we encounter a somewhat similar state of affairs in the published experimental data dealing with the carcinogenic power of the ultraviolet rays of the spectrum. There seems to be no doubt that ultraviolet light is a factor in initiating skin cancers, but there is a clear cut conflict of opinion as to whether or not these rays serve to hasten the process of cancer development in mice that have been tarred.

Findlay (7) impressed by the citations in the literature of the high incidence of skin cancer in sailors, bargemen, fishermen, lightermen, farmers, gardeners, and graziers, in America, England, France, Italy and Australia, concluded that even if the statistical value of the various reports were not high,

they nevertheless suggested strongly that sun light and ultraviolet light may play an important part in the genesis of cancer

In order to check this assumption, Findlay exposed mice to the rays of a quartz mercury vapor lamp. His conclusions were (1) Exposure of mice to ultraviolet rays for a period of at least 8 months caused the development of papillomata and epitheliomata (malignant) of the skin. (2) When mice were tarred and exposed to ultraviolet light the period necessary for the induction of cancer was shorter than when either tar or violet ray exposure was used alone. (3) A series of 20 mice, tarred for one month did not develop cancer, but in a similar series tarred and exposed to ultraviolet light at the same time 3 mice developed cancers.

In a later paper Findlay reported the development of cancer in rats following exposure to ultraviolet light. The period necessary for induction of the cancers in rats was 21 months, in contrast with 8 months in mice but Findlay attributes the increased time element to the species difference rather than to the nature of the stimulus.

Herlitz, Jundell and Wahlgren exposed 27 mice to ultraviolet rays for 1 to 2 hours every 1 to 3 days for 7½ months (quartz lamp 70 centimeters distance). After 200 days 17 mice were alive and all of them showed one or more skin tumors most of which were carcinomata. A group of control animals showed no tumors.

Putschar and Holtz exposed 57 rats, day and night, to ultraviolet rays at a distance of 60 centimeters. After a period of more than 6 months, 13 of the 35 living animals developed malignant new-growths. These authors question the accuracy of Findlay's observations because of his much shorter exposures.

Rathman and Bernardt also question Findlay's conclusions and report that using rabbits they were not able to produce experimental cancer after 9 months of daily exposure to ultraviolet rays.

Kohn Speyer reached the conclusion from her experiments that irradiating mice with ultraviolet light as an adjunct to tarring does not produce tumors (warts) more quickly than does tarring alone. She is unable to explain the discrepancy between Findlay's and

her findings but suggests that Findlay's rested on some as yet undetermined cause other than ultraviolet radiation alone.

There remains for discussion the work that has been done in natural light, in light in other than the violet end of the spectrum, and in the absence of all light. With the exception of the clinical observations of the supposed relationship between sunlight and skin cancers which we have already noted and the work of Roffo on the carcinogenic potency of photo-active cholesterol which we have also discussed, very little work has been done with pure sunlight. Neumann in an experimental study of tar cancer merely mentions the fact that animals (mice) exposed to "intense illumination" showed no greater tendency to develop malignant tumors than did those that were kept under ordinary conditions.

From what we know of the rôle that light plays in some of the diseases of metabolism, and from what we know of the clinical effects of light deprivation it is not difficult to imagine that this same agency may be a factor in the origin and growth of cancer. A recent paper by Dodds calls attention to some of the work done by Warburg illustrating by "a remarkable observation" the influence of light on the process of cell respiration: "if a slice of tissue is poisoned with carbon monoxide (CO) gas cell respiration is strongly inhibited in the dark, but reappears when the tissue is brightly illuminated."

It is of course self-evident, that one of the approaches to the problem of light as a carcinogenic agent lies in the direction of determining the effect of its total exclusion. The value of such an approach, it seems to us lies in large part in securing total darkness in the photochemical sense. Animal experimentation under such conditions is not easy of accomplishment. Marsh emphasizes this when he calls attention to inadequate ventilation and high temperature as compromising features of his experiments. Dodds (who kept his mice in individual darkened cages) reports that mice can develop tumors in darkness but by his own statements he admits that his cages were "nearly light tight" and that the darkness in the cages was "all but complete." If we are testing the effect of absence of light,

then light must be absent and not partially absent. In Part I of this paper we have described in detail how exclusion of light may be accomplished without in any other way interfering with the routine life of mice.

In addition to Dodds the following workers have studied the effect of absence of light: Bang Lipschuetz Schorr and Ssobolewa, and Vlès De Coulon and Ugo. Half of these workers report that complete darkness exercised no influence on the development or growth of tar cancers, whereas the other half report that darkness tends to inhibit the development of tar cancers. Bang mentions, incidentally that mice kept in complete darkness develop cancer as rapidly as do control animals. Unfortunately he furnishes no information as to what constitutes *obscurité complète* in his experiments, how many animals he used in his light experiments or what were his criteria of malignancy. The fact that in all his experiments (including the ones done in darkness) he secured 115 cancers in 263 mice arouses the suspicion that what he called cancer would not be so classified in our laboratory. Bang's work leaves a residuum of doubt on several counts, and leaves room for confirmatory work.

Lipschuetz is very definite in his statement that he worked in a well constructed photographic dark room though no mention is made of means of regulating temperature or ventilation. He found that darkness played no inhibitory rôle in the development of pigment (melanomata) in his tarred mice. But here again one is left in reasonable doubt regarding the significance of darkness in the development of tar cancer because Lipschuetz was exclusively studying pigment formation and in black and gray mice.

Schorr and Ssobolewa divided tarred white mice and mice with transplanted tumors into groups (14 to 58 mice in a group) and subjected each group to varying light conditions which were maintained during the process of tarring. They concluded from their experiments that light cannot be disregarded as a factor influencing the development of experimental cancer. Absolute darkness seemed in some instances to have no effect but as a rule darkness and also exposure to blue rays

retarded the development of cancer and also lessened the tendency of the tumors to ulcerate. In spite of repeated careful reading of the article by Schorr and Ssobolewa, we could not determine how they excluded light, nor how efficiently it was excluded.

Vlès, De Coulon and Ugo merely make the unsupported statement that when mice were kept in close confinement in dark cages, a retardation in the development of cancer in the tar painted animals occurred. Naturally one has difficulty in determining just how to evaluate such a statement.

The conclusion that one must almost inevitably draw from a survey of the literature on light as a carcinogenic factor is that more direct experimental evidence and data must be furnished if one hopes either to confirm the hypotheses that have been put forward or to evaluate the worth of conflicting conclusions that have been drawn from experimental data. With such an object in view the experiments detailed in Part I of this paper were planned and executed.

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THE RESISTANCE OF HEALING WOUNDS TO INFECTION

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THE purpose of this experimentation was to determine the degree of infectibility of simple incised and sutured wounds subsequently swabbed with a culture of pathogenic organisms after various intervals of time.

Howes, Boov, and Harvey studied the rate of healing of clean incised sutured wounds in dogs by mensuration of the tensile strength of these wounds at definite intervals. They concluded that there exists a quiescent phase or lag period of from 4 to 5 days characterized by fibrin formation in the blood or plasma exuded between the surfaces of the fresh wound. During this interval the approximation of the incised tissue is dependent upon the mechanical coaptation of its sutures. From the sixth day on, however—

the period of fibroplasia, manifest by multiplying fibroblasts and sprouting blood vessels—the wound rapidly develops intrinsic holding power until from the tenth to the fourteenth day its tensile strength reaches a maximum comparable to that of unincised tissue.

Carrel (3) studied the mechanisms of the repair of surgically aseptic cutaneous open wounds in dogs by measurement of the variations in their dimensions. He showed that there is a quiescent period lasting from 1 to 5 days during which the dimensions of the wound do not vary. This is followed abruptly by a period of granulous retraction. The rate of reparation of the granulous period is directly proportional to the size of the wound. The end of this period coincides with the beginning of the period of epidermization which is inversely proportional to the dimensions of the wound. This period is succeeded by the period of cicatrization, of considerable length, during which progressive enlargement of the scar occurs. In a later report, Carrel and LeComte Du Nouty (4) state that the latent period of cicatrization in dogs varies generally from 5 to 7 days. It stops abruptly and contraction starts with

maximum velocity. Carrel and Hartmann (5) found in subsequent experiments that when a surgically aseptic open wound becomes infected, arrest or regression of the repair occurs, yet the senior author states that the application of turpentine chick embryo and staphylococci decreases markedly the length of the latent period often to less than 2 days. This work is of considerable interest in relationship to our findings.

Billroth, one of the first to make a study of wound infections, demonstrated that granulating surfaces offer considerable resistance to infection. Virulent organisms, implanted on granulating tissues of dogs, cause no infection, but these same bacteria inoculated into fresh wounds result in extensive infection in some instances leading to the death of the animal. He believed that this resistance of granulation tissue is due to lack of lymphatics. Noetzel and Afanasieff, working on absorption of poisons from granulating tissues, both independently came to the conclusion that granulation tissue affords considerable protection against the invasion of bacteria. Halley, Chesney and Dresel, demonstrated that granulations constitute a relatively unfavorable environment for the survival and growth of *Streptococcus erysipellatus* and *Staphylococcus aureus*.

It is a clinical truism on the other hand that fresh wounds are readily infected. In 1897 Schimmelbusch and Ricker showed that there is rapid absorption of both pathogenic and saprophytic bacteria from fresh bleeding wounds. W. H. Welch states: The period during which the rapid absorption of bacteria from a fresh wound takes place is of short duration. As soon as a coagulum has formed on the surface of the wound, the open mouths of lymphatics and blood vessels are plugged, the conditions have changed and fine particles like bacteria are no longer quickly transported into the intact lymphatics and blood circulation. The surface of a healthy granulating wound offers great resistance to the invasion

of bacteria almost as much as an intact exposed surface of the body. Slight injuries, such as probing removal of dressings and other manipulations may convert a granulating surface into a fresh wound with accompanying dangers of infection."

However, from an experimental point of view that period in which an operative incision changes from an excellent locus of infection to one offering protection comparable to that of intact epidermis is not known. That period in healing, in which a wound may be manipulated without danger of resulting infection through surface implantation of organisms whether by wilful or unintentional abandonment of the principles of asepsis has not been demonstrated.

PROCEDURE

From the Surgical Wards of the Peter Bent Brigham Hospital a 24 hour broth culture of *Staphylococcus aureus* *hæmolyticus* was obtained from an abscess of the buttock, 0.5 cubic centimeter of this culture was injected subcutaneously into each of four guinea pigs, and in three days all developed typical abscesses. Smears of the pus demonstrated the organisms in pure strain. This strain was kept on plain agar and its virulence maintained and checked by weekly inoculations into guinea pigs. Six hours prior to its experimental use it was transferred to dextrose infusion broth, 0.5 cubic centimeter of this 6-hour broth culture being used in each of the experiments.

The operative technique in all experiments was the same. The abdomen of each pig was widely shaved and cleansed with green soap and water. The operative field was carefully prepared with 70 per cent alcohol and bichloride of mercury (1:4000). The abdomen was draped in the usual manner. Under ether anesthesia an incision 5 centimeters in length was made through the skin subcutaneous tissue and abdominal musculature. Hemostasis was assured. The musculature was then carefully approximated with interrupted fine black silk sutures and the skin closed in like manner care being taken to leave no dead spaces or gaping edges. A sterile dressing was applied and kept intact

with adhesive, simulating Montgomery straps. These were found very satisfactory and anchored the dressing down tightly. To guard further against contamination of the wound the animal's legs were fastened with rubber bands which necessitated the maintenance of a dorsal position.

Thirty incisions were made in each series of experiments, except the first in which forty two were made. In the first series no organisms were implanted, in the second, immediately at the close of operation 0.5 cubic centimeter of a broth culture of *Staphylococcus aureus* *hæmolyticus* obtained as described above was gently swabbed along the operative site, and a sterile dressing applied. In the third, 2 hours were allowed to elapse before the sutured wound was similarly treated, in the fourth series 6 hours, in the fifth, 12 in the sixth 24, and then 24 hours later in each subsequent series. Control experiments were performed both independently and in conjunction with each series as to the virulence of the organisms, the resistance of the intact skin to resist these organisms and on the ability of the un inoculated wound to heal by first intention.

RESULTS

1. Operative incisions in guinea pigs, made and followed with aseptic technique, heal by first intention. In 42 operative procedures 41 wounds healed without infection. One developed a small stitch abscess on the fifth day. Stitches were removed routinely on the sixth day, and on the eleventh day the scars were scarcely discernible.

2. *Staphylococcus aureus* *hæmolyticus* implanted upon the intact skin does not cause infection. The organisms were smeared on the shaved abdominal wall of forty guinea pigs. No infection occurred.

3. In the first series of 30 animals *Staphylococcus aureus* *hæmolyticus* was implanted along the line of closure at the completion of the operative procedure. Within 4 days gross infection was present in all cases. Four guinea pigs died of overwhelming infection within 3 days, 3 had extensive spreading infections of the anterior abdominal wall, 20 developed gross abscesses in the subcutaneous

tissue and muscle layers and 3 an accumulation of suppurative fluid beneath the skin. Microscopic sections confirmed the gross findings. Gram stains revealed staphylococci in great numbers. The three control incisions healed without infection.

4 In the second series *Staphylococcus aureus hemolyticus* were implanted upon the sutured wound 2 hours after operation. Gross infection was apparent in all incisions within 4 days. Five guinea pigs died of overwhelming infection within 3 days. Two developed an extensive spreading infection of the anterior abdominal wall. Twenty-two had gross abscesses and one an accumulation of suppurative fluid beneath the skin. The controls were uninfected. Their findings were substantiated by microscopic examinations. Large numbers of staphylococci were found in all inoculated incisions.

5 In the third series staphylococci were implanted upon the sutured wound 6 hours after operation. Infection was present in all incisions within 4 days. One pig died of overwhelming infection within 3 days. There were no extensive infections of the abdominal wall. Twenty-eight incisions developed gross abscesses. One incision showed no evidence of infection grossly but microscopic examination revealed its presence. The control incisions healed by first intention. The organisms were found in large numbers in all the infected wounds. In general, the infections were less extensive in this series than in the two preceding ones.

6 In the fourth series staphylococci were implanted upon the sutured wound 12 hours after operation. Infection was present in 83 per cent of the incisions within 4 days after implantation of the organisms. There were no deaths and no extensive infections in contrast to the previous series. Twenty-one incisions contained gross abscesses. Microscopic evidence of infection was found in four incisions though not manifest grossly. Five (17 per cent) showed no gross or microscopic evidence of infection. The control incisions healed *per primam*. The organisms were demonstrated in all the infected wounds. There was a marked decrease in the severity of infections in this series.

7 In the fifth series, staphylococci were implanted upon the sutured wound 24 hours after operation. Infection was present in 66 per cent of the incisions within 4 days, after the implantation of organisms. There were no deaths and no extensive infections. Fifteen wounds had gross abscesses, only one of which was at all severe. Staphylococci were present in these lesions. Five showed unmistakable evidences of infection microscopically, which was not apparent grossly. In 4 of those incisions demonstrated to have infection only by microscopic means no organisms were found. Ten incisions (33 per cent) were healing *per primam intentionem*. The controls were negative.

8 In the sixth series staphylococci were implanted upon the sutured wound 2 days after operation. Infection was present in 56 per cent of the incisions within 4 days after the implantation of organisms. There were no deaths and no extensive infections. Thirteen incisions were found to have gross abscesses, two of which were severe. Four incisions showed no gross evidence of infection but microscopic sections revealed its presence. Thirteen incisions (44 per cent) were healing by first intention. Staphylococci were present in all the gross lesions, and in 3 of the 4 microscopic lesions. The controls were negative.

9 In the seventh series staphylococci were implanted upon the sutured wound 3 days after operation. Infection was present in 36 per cent of the incisions within 4 days after the implantation of organisms. Six incisions contained gross abscesses, in all of which staphylococci were found. None of these abscesses were over 0.5 centimeter in diameter. Five wounds showed evidence of infection on cut section although not visible grossly. In 2 of these staphylococci were identified. Nine incisions (64 per cent) showed no evidence of infection. The controls were negative.

10 In the eighth series staphylococci were implanted upon the sutured wound 4 days after operation. Infection was present in 10 per cent of the incisions within 4 days after the implantation of organisms. One incision was found to have a gross abscess 0.1 centimeter in diameter in which the staphylococcus was identified. Two showed unmistakable

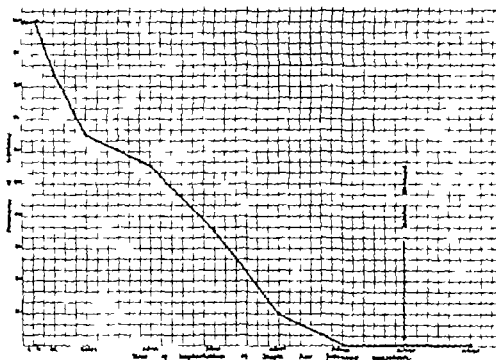


Fig. 1. Curve showing relationship of infection to time of implantation of organisms in sutured wounds.

evidence of infection microscopically but not grossly. No organisms were shown in these two sections. Twenty seven (90 per cent) healed by first intention. The controls were negative.

11. In the ninth series staphylococci were implanted upon the sutured wound 3 days after operation. Gross and microscopic examination revealed no infection.

12. In the tenth series staphylococci were implanted upon the wound 6 days after operation, immediately following the removal of all skin silks. No infections could be demonstrated either grossly or microscopically. In 7 instances the wound was partially reopened while pulling out the stitches and the organisms were swabbed into the defect without resulting infection.

13. In the eleventh series, staphylococci were implanted upon the wound 7 days after operation and 24 hours following the removal of the skin silks. No infections could be demonstrated either grossly or microscopically. On the eleventh day after operation, when the wounds were examined it was only with difficulty that the operative incision could be identified.

DEDUCTIONS

These results demonstrate that after an incision of tissue there follows a well defined

period about 6 hours in length in which that tissue's resistance to invasion by bacteria is at a minimum. In this period bacteria not only flourish and cause suppuration in the local lesion but invade without apparent restraint the adjoining tissues, setting up extensive, rapidly spreading infections which in a number of instances result in the death of the animal. After this period, however, the factors concerned in the repair and protection of tissue become increasingly apparent. When organisms are implanted upon a sutured wound 12 hours after operation, although the great majority of incisions become infected (83 per cent) the infections are localized. No systemic infections develop, which overwhelm the animal, and no extensive spreading suppuration occurs. From this time on, the percentage and severity of infections steadily decreases (see Table I) until between the fourth and fifth post-operative days it is no longer possible to cause infection by implantation of virulent organisms on the surface of the wound (see graph).

This period of from 4 to 5 days coincides with the 'lag period' of healing wounds, described by Harvey (7) and by Carrel (3) and which Harvey points out is common to all growth phenomena. This period is charac-

TABLE I.—DURATION OF INFECTION

Degree of infection	Time of implantation of <i>Staphylococcus aureus</i> following operation										
		1 hr	6 hr	1 hr	24 hr	days	2 days	4 days	5 days	6 days	7 days
Severe		3	7	7							
Abcess 1 cm in diameter	3		7								
Abcess 5 cm in diameter		3	8	5	4	4	3				
Abcess 2-3 cm in diameter	3			8	8	3					
Abcess 1-0 cm in diameter						3					
Microscopic only				4	5	4	5				
None				5	10	3	9	27	30	30	30
Total infections	30	30	30	5	20	7		5			
Percentage infections	100	100	100	8.3	66	23	30	16			

tenized by fibrin formation in the blood or plasma exuded between the surfaces of the fresh wound. This fibrin formation apparently has but little resistance against the invasion or multiplication of bacteria and it is only when it has been replaced by fibroblasts that protection against bacterial invasion becomes complete. It would seem therefore, that resistance to infection is not complete until the lag period of a healing wound (4 to 5 days) has been succeeded by what Harvey speaks of as the period of fibroplasia—manifest by multiplying fibroblasts and sprouting blood vessels.

It is of clinical importance that for the first 5 days following an operative incision extreme care be taken in the manipulation of a wound as during this period infection is possible from implantation of virulent organisms on its surface.

On first thought it might seem surprising that when virulent organisms are implanted along a wound on the sixth day immediately following the removal of stitches no infection results. However upon consideration that these stitches have become walled off by granulation tissue which is highly resistant to the invasion of bacteria, it is readily understood. Even in those instances in which due to a sudden movement of the animal while removing a stitch, a small segment of the wound was reopened no infection developed although the organisms were swabbed into this defect. This is likewise explainable upon the same factor of resistance of granulation tissue to the invasion of bacteria.

SUMMARY

1. The resistance of a healing wound to infection is minimal during the first 6 hours.
2. After the first 6 hours infections decrease in number and severity until fifth day.
3. On the fifth day after operation, the resistance of a wound to infection has reached a level comparable to that of intact tissue.
4. Removal of stitches on the sixth day after operation does not lower the resistance of the wound to infection.
5. The period of infection corresponds to the lag period of healing wounds.

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THE SURGICAL REMOVAL AND HISTOLOGICAL STUDIES OF SYMPATHETIC GANGLIA IN RAYNAUD'S DISEASE, THROMBO-ANGIITIS OBLITERANS, CHRONIC INFECTIOUS ARTHRITIS, AND SCLERODERMA

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THE surgical removal of sympathetic ganglia has been followed by relief of symptoms in selected cases of Raynaud's disease (2) thromboangiitis obliterans (3) chronic infectious arthritis (19) and the acral type of scleroderma (4) but studies of the ganglia removed have been inadequate to determine the presence of any constant histological changes.

Operations consisting of the removal of ganglia have stimulated interest in the clinical physiological and pathological aspects of the sympathetic nervous system. This study is based on 108 cases in which the cervicothoracic sympathetic ganglia were removed to obtain sympathetic denervation of the upper extremities and the second, third and fourth lumbar sympathetic ganglia were removed to obtain sympathetic denervation of the lower extremities. In all cases removal of the cervicothoracic ganglia was carried out according to the technique described by Adson (1) consisting of posteromedian incision over the lower cervical and upper thoracic vertebrae followed by the bilateral removal of the transverse process and a portion of either the first or second rib permitting entrance into the posterior mediastinum and access to the cervicothoracic sympathetic trunk. The lumbar sympathetic trunk was removed through a median abdominal and bilateral transperitoneal incision, the second, third, and fourth sympathetic ganglia on both sides at the same operation (2) being removed.

In a certain number of operations for the removal of sympathetic ganglia, indications of inflammatory reaction in both the posterior mediastinum and in the postperitoneal tissues were found. In the abdomen enlarged lymph nodes frequently interfered with the exposure

of the sympathetic chain to such an extent that it was necessary to dissect and remove them before the operation could be completed. Although enlarged lymph nodes were not encountered in the posterior mediastinum the difficulty of dissecting the sympathetic trunk due to adhesions suggested the presence of mild mediastinitis. These observations at operation raised the question of local inflammatory reaction playing some part in the dysfunction of the sympathetic system by involving the ganglion tissues and cells. Consequently we have been making a study of the ganglia removed at operation and not only have examined them histologically but have cultured them on different mediums to investigate possible bacterial invasion. The ganglia which have been removed have been kept sterile emulsified and cultured in glucose brain broth and brain agar. In only a few instances have there been any positive cultures and these Rosenow reported as consisting of pleomorphic streptococci.

The local inflammatory reaction about the sympathetic ganglia in the operative cases aroused our interest to such a point that observations were made in 40 non-operative cases at postmortem in which derangement of function of the sympathetic nervous system had not been apparent. It was surprising to find that in a large percentage of these cases the lymph nodes lying postperitoneally along the vertebral column and superimposed on the lumbar sympathetic chain were enlarged and simulated the picture seen at operation but this could not be established as an inflammatory process.

In order to correlate the clinical, surgical and pathological aspect of these cases, we have tabulated our histological observations to correspond to the clinical diagnoses and

although all the ganglia have been investigated we are presenting four clinical histories from the entire group of cases as a background of our pathological considerations. These cases have been chosen not only because they represent the diagnostic groups, but also because they responded exceptionally well to the therapeutic application of sympathetic ganglionectomy. Therefore any pathological changes occurring in the ganglia should have been evident in these cases.

In the cases of Raynaud's disease, 50 were submitted to operation in some of them bilateral lumbar ganglionectomy in some bilateral cervicothoracic ganglionectomy and in others both operations were done.

RAYNAUD'S DISEASE

This disease occurs in adult life, predominating in women and is characterized by the presence of symmetric changes in the color of the hands and feet or of the fingers and toes. It may involve the upper or lower extremities, and occasionally the nose and the lobes of the ears. The blanching of the skin is brought about by vasoconstriction of the vessels, due to exposure to cold or emotional influences. This blanching is followed by cyanosis, which continues until the vasoconstriction subsides. In the earlier stages of the disease, this subsidence is accompanied by discomfort, then by aching and finally by severe pain. As the disease progresses the changes in color become more prominent and the skin remains more or less cyanosed unless the condition is relieved by the application of heat externally. Should the vasoconstriction become prolonged and the circulation markedly decreased gangrene may occur. Gangrene in Raynaud's disease differs from the gangrene which occurs when the vessels are occluded in that it produces dry ulcers at the tips of the fingers or toes with distorted growth of the nails, instead of complete gangrene of one of the digits. If the process is allowed to continue the gangrene will ascend and will become extremely painful. Usually the patient complains of subjective numbness, which interferes with the function of the extremity and adds to the general discomfort and incapacitation. The disease does not always progress to

the severe forms hence the milder forms may be controlled by changing occupation or climate. When the symptoms persist, and ulceration and gangrene develop operation should be performed. In almost all the cases in which operation has been performed, the relief of pain is almost instantaneous, the cyanosis disappears and the skin becomes warm pink and dry the ulcers heal the nails take on normal growth, and the patient is restored to normal health.

Illustrative case. A woman, aged 25 years, gave a history of blanching of the right index finger 3 years previous to registering at The Mayo Clinic. This came on during the winter months, but disappeared in summer. The next winter, however the condition became gradually worse, both hands becoming cyanotic to the wrists, associated with numbness and dull aching pain. This did not clear up with the advent of warm weather and the following winter small dry ulcers developed in different finger tips, and the feet also began to manifest the symptoms of color changes and pain when exposed to cold.

General examination was essentially negative except for marked vasomotor changes in the extremities. A diagnosis of Raynaud's disease was made, and because the hands were more involved than the feet cervicothoracic sympathetic ganglionectomy was performed. The stellate and second thoracic sympathetic ganglia were removed from both the right and left sides (Fig. 1). The patient's convalescence was uneventful and she was completely relieved of cold, blue, numb hands 15 days after operation the ulcers on the tips of the fingers had completely healed.

An interval of 6 weeks was allowed to elapse before operative interference to relieve the lower extremities was thought advisable. The patient's complaint concerning her feet was similar to that concerning her hands in that there were marked grades of cyanosis on exposure to cold, mild pain, numbness, and tingling followed by periods of recovery during which there was burning, redness, and sweating. The symptoms were completely relieved after bilateral lumbar sympathetic ganglionectomy at which time the second, third, and fourth lumbar sympathetic ganglia were removed on both sides (Fig. 1).

In these as in all the other ganglia removed various points were noted. The blood vessels showed a mild degree of thickening of the wall with subsequent narrowing of the lumen so that the ratio of lumen to wall which is normally 2 to 1 in small arteries was now only 1.7 to 1. In addition in a few arterioles there was an increase in prominence of the lining endo-

thelial cells, but this was by no means universal and was present only in a mild degree. There was no evidence of acute or chronic inflammation, there were no fibroblasts or increase in the connective tissue as shown by the van Gieson stain, and polymorphonuclear leucocytes were not present. Although there was no inflammation lymphocyte like cells were present and these were in two small groups and not scattered diffusely throughout the ganglia. At one end of the ganglia there was slight edema of the connective tissue. This varied greatly in the various ganglia removed for this condition and was never pronounced. Besides the stains used as a routine, thionin stain, Orlandi silver impregnation method, Horta's silver carbonate method and Cajal's gold chloride and sublimate method were employed in the study of the ganglion cells. In the case under consideration there was little change in any of the cells other than that seen normally. There was slight chromatolysis in less than a third of the cells and slight vacuolization in the periphery of some of the others. This was not advanced and was present in about half of the cells. In the same cells some of the endocapsular cells were prominent, and the vacuoles in the periphery of the ganglion cells appeared to be caused by swelling of the endocapsular cells. Some of the capsular cells thus appeared as deep-staining nuclei with clear spaces around them causing excavations of the cytoplasm of the underlying ganglion cells. Only occasionally was there any demonstrable increase in the ectocapsular cells. The various special stains were unsatisfactory in demonstrating the bodies of the endocapsular cells. In a seventh of the ganglion cells pigment granules were not present, whereas in about five sevenths a slight amount was present (graded 1) and in the remaining seventh there was considerable pigment (graded 2). This is a normal phenomenon and is seen constantly in increasing amounts in normal ganglia with advancing age. In ganglia removed from patients with Raynaud's disease in the group in which there was no pigment, the average age of the patients was 24.3 years, in the group in which pigment was graded 1, the average age was

33.7 years, and in the group in which it was graded 2 the average age was 40 years, thus conforming to the tendency for increased pigment deposition in many nerve cells, especially sympathetic ganglia with advancing age. There is, in any control series of ganglia, a marked variation in pigment precipitation but it is almost always more abundant in the ganglion cells of older persons than in those of younger persons.

THROMBO-ANGIITIS OBLITERANS

There were 97 patients with thrombo-angiitis obliterans on whom the cervico-thoracic or lumbar ganglionectomy or both types of operation were performed and the ganglia removed were studied histologically.

Thrombo-angiitis obliterans occurs in adult life, has a predilection for men and affects persons of all races in spite of the fact that it formerly was supposed to occur more commonly among Jews. The underlying causes have not all been determined. The disease seems to progress after infection of the inner walls of the arteries and formation of a clot which occludes the vessels, thus decreasing the blood supply to the extremity. The infection and the formation of the clot vary in degree and distribution. The condition may affect the distal part of one principal artery, or it may include all the principal arteries of all extremities at different periods. The usual course of this disease is rather slow; the main vessels of the feet and legs become involved early and those of the upper extremity later. When it is economically possible relief can be obtained by discontinuing work, remaining at rest in bed, applying heat to the extremities and being treated with vaccines administered intravenously. In time organization of the intravascular clot takes place and circulation is restored. However many patients are compelled to work, subjecting their hands and feet to trauma, and ulcers may develop sooner or later and refuse to heal. These ulcers become infected, the infection spreads to the adjacent tissues, and more thrombosis and gangrene appear, necessitating amputation of the extremity (9). By means of operations on the sympathetic system, it is possible to relieve the vasomotor spasm of the col-

lateral vessels, which improves circulation tends to prevent ulceration infection and gangrene and hastens healing of existing ulcers and abrasions. In suitable cases selected by means of the various tests of altered vasoconstriction [Brown's fever test (7) White's (22) diagnostic nerve block and White (22) Morton and Scott's (16) spinal anesthesia test] the temperature of the skin is increased from 2 to 10 degrees, depending on the amount of vasoconstriction present before the operation, the ulcers begin to heal and the patient is restored to his former status as a wage earner. Moreover the operation may prevent further gangrene and extension of the process to the opposite extremity which usually is involved to a slighter degree than the extremity which causes the symptoms. Operation is not advised for milder cases in which the patients are not inconvenienced greatly, are free from ulcers, and are able to carry on regular work under symptomatic treatment. The normal expectancy for amputation of one or more limbs in cases of thrombo-angitis obliterans even under ideal conditions is more than 25 per cent, but there has been a definite reduction of this percentage in cases in which sympathetic ganglionectomy has been performed. Less than 5 per cent of the patients who have left the clinic following operations on the sympathetic ganglia have been obliged to submit to subsequent amputation (6). This comparison emphasizes the value of operations on the sympathetic system in protecting patients with thrombo-angitis obliterans from losing one or more extremity by amputation.

Illustrative case. A man aged 35 years, came to the clinic complaining of pain in the feet and legs associated with ulcers and cyanosis of the toes. His history dated back almost 12 years, when after trauma to the right instep he experienced intermittent pain in walking. Six years following this, cyanosis, rest pain, and ulceration in the right little toe developed, which proved very indolent to treatment. Five years after the trouble with the little toe began, a similar condition developed in both great toes and the ulcers remained open for several months. Following this, cyanosis occurred in both feet, and intermittent pain developed. Two months before registration at the clinic, the four lateral toes on the left foot became blue and cold, and ulceration occurred between third and fourth and fourth and fifth toes.

On examination the lower extremities were cold and blue. The femoral and popliteal pulses were present on both sides, the posterior tibial artery on the right was partially occluded and completely occluded on the left, both dorsalis pedis arteries were occluded. The right foot was cold and dark, but did not contain ulcers, the left foot was cyanotic, especially over the lateral portion, and indolent ulcers were present between the third and fourth and the fourth and fifth toes.

A diagnosis was made of thrombo-angitis obliterans with vascular insufficiency. Intravenous typhoid vaccine was given which was followed by increase of surface temperature sufficient for a satisfactory vasomotor index. Bilateral lumbar sympathetic ganglionectomy was carried out, and the second, third, and fourth lumbar sympathetic ganglia were removed (Fig. 1). There was evidence of an inflammatory reaction about both sympathetic chains. The patient recovered uneventfully and when seen almost a year after operation, he was working and was well satisfied with the result obtained in his case.

Histological study of the ganglia showed that there was more proliferation of the lining endothelial cells of the arterioles and small arteries than in the cases of Raynaud's disease which we have studied, but this proliferation was by no means universal. There was also slight thickening of the walls of the larger vessels present in the ganglia, so that the normal ratio of lumen to wall (2 to 1) was reduced to 1.8 to 1 and is thus less than that seen in the vessels examined in cases of Raynaud's disease. There was no evidence of acute or chronic inflammation. Fibroblasts were not present and excessive connective tissue was absent as demonstrated by special staining methods. Several small collections of lymphocyte-like cells were present, but none were scattered diffusely throughout the ganglia. The groups were not associated with blood vessels. There was mild edema of the connective tissue, but this was not universal in the ganglia. The edema was more marked in the ganglia removed from patients suffering from thrombo-angitis obliterans than from any other ganglia studied. Special staining methods were employed in studying the ganglion cells themselves, but the changes that were present were very slight. There was a mild degree of chromatolysis in about a seventh of all the cells whereas a fourth were normal. In more than half of the cells small vacuoles were present at the periphery and these corresponded

in situation to the endocapsular cells. The vacuoles appeared to have been caused by swelling of the endocapsular cells, the nuclei of which were prominent and cytoplasm could be demonstrated only with difficulty with the special stains that is, Cajal's gold chloride and sublimate method and Hortega's silver carbonate method for microglia and oligodendroglia. The deep-staining nuclei were surrounded by a clear space such as is seen in acutely swollen oligodendroglial cells described by Penfield and Conc. Mucus stains revealed only slight traces of some of these vacuoles. There were several cells which had been replaced by large vacuoles and remnants of the ganglion cells were compressed at one part of the periphery against the cell capsule. This process of vacuolar degeneration or destruction seemed to be different from changes brought about by swelling of the endocapsular cells. The swollen endocapsular cells corresponded closely to the vacuolization present in the periphery of cytoplasm of the ganglion cells. Pigment was present in the cytoplasm of more than 90 per cent of the ganglion cells but was slight in amount in 75 per cent of the cells. There was considerable pigment in 20 per cent of the cells and there were few cells in which there was pigment graded 3. The average age of the patients with thrombo-angitis obliterans was 35.7 years. The average age of patients with out pigment in the ganglion cells was 29.6 years, of those with pigment graded 1 the average age was 36.8 years and of those graded 2 the average age was 46 years, the one patient with pigment graded 3 was aged 53 years. This again conforms with the tendency for pigment to increase with advancing age in nerve cells and especially in the sympathetic ganglion cells.

ARTHRITIS

Ganglia from 46 patients with arthritis were studied histologically. In some cases both the upper or lower extremities were denervated, and in others all four extremities.

Among the various types of patients suffering from chronic infectious arthritis are young adults who have painful swollen tender joints, associated with limited motion, atro-

phy of the muscles, and loss of function. Patients complain also of cold extremities, mild changes in color of fingers and toes and excessive perspiration. There is a tendency for the condition to progress slowly, it is not altered by removal of foci, immobilization, massage or exercise, and is symptomatically relieved only by the application of various types of heat. In certain selected cases of this group operations on the sympathetic ganglia are followed by relief of symptoms and by the improvement in circulation which follows the vasodilatation. The skin becomes warm and dry and pain is generally relieved. The tenderness tends to disappear and the swelling subsides. In selecting suitable cases for the operation the rise in surface temperature of the extremity following intravenous administration of typhoid vaccine is used as an index, and if there is no appreciable rise in surface temperature or relief of symptoms following protein injections the operation is not indicated.

The following case is reported because it presents the salient features of a slowly progressive arthritis not yielding to the usual therapeutic measures. The associated vasomotor changes as evidenced by the cold clammy extremities which were temporarily relieved by the intravenous administration of typhoid vaccine formed the basis for sympathectomy. The history of psoriasis and the presence of mild lesions at the time of examination raised the question of a differential diagnosis of chronic infectious arthritis and arthropathia psoriatum (13). The clinical features, however, were those of the former and the excellent response to operation rendered this case most suitable for histological study.

Illustrative case. A man, aged 40 years, came to the clinic complaining of pain, stiffness, and deformity in the fingers and toes. Four years before admission he began to have swelling, redness, and pain in the right index finger. The remaining digits of the right hand became similarly involved and gradually the left hand became affected with the same process. The condition progressed and after 2 years had elapsed the toes on both feet began to swell and to become painful and stiff. The arches ached with activity but were relieved by rest. This condition progressed to the point where the patient was unable to walk or use his hands without pain and discomfort.

Examination disclosed areas of paresthesia on the upper midsacral regions and outer surface of the right leg which had been present intermittently for the previous 6 years. There was moderate swelling of the left wrist with tenderness and 20 per cent limitation of dorsal flexion. Both hands were cold and slightly clammy with swelling and motion of phalangeal joints was limited. There were trophic changes in the fingernails. Both feet were cold and clammy. There was marked swelling and tenderness at the base of the toes on both feet and tenderness on pressure over both arches. Both hands and feet were cyanotic. Roentgenograms revealed healed tuberculous lesions in the upper part of the right lung. One dead tooth was found, and removed. Mild prostatitis was treated. Because of the evident associated vasomotor spasm of the peripheral arteries, typhoid vaccine was given intravenously which was followed by marked relief of pain and the skin over the extremities became warm and pink. When the surface temperature was compared with that taken before the injection had been given a marked rise had taken place thus establishing a satisfactory vasomotor index.

Bilateral lumbar sympathetic ganglionectomy (Fig. 1) was performed. The second, third, and fourth lumbar sympathetic ganglia were resected on both sides. There was a marked inflammatory reaction about the sympathetic chain and the overlying lymph nodes were enlarged and inflamed. The lymph nodes were removed and microscopic section revealed fatty fibrosis with inflammatory nodules. Following an uneventful convalescence, the patient was relieved of almost all the pain in both feet; they became warm and cyanosis disappeared.

The question of cervicothoracic sympathectomy was considered, but the patient wished to wait for time to evaluate the improvement in the lower extremities. Six months later examination revealed increased severity of the condition of the hands. The patient was walking without pain, his feet were warm and dry, and he requested that a second operation be considered. Bilateral cervicothoracic sympathetic ganglionectomy (Fig. 2) was done, removing the stellate and second thoracic ganglia after resecting the transverse process and part of the first rib. Marked alleviation of pain in both hands followed. After an uninterrupted convalescence the patient returned home, continuing to improve until he could use his hands without pain and with very little residual stiffness (Fig. 3).

The changes observed histologically in these ganglia were similar to those described in the ganglia removed from patients suffering from Raynaud's disease and thrombo-angitis obliterans. Most of the blood vessels were normal but in a few there was mild proliferation of the lining endothelium of the intima and in others there was slight thickening of the walls of the larger arteries in the ganglia.

The ratio of lumen to wall in this group was 1.8 to 1 instead of the normal 2 to 1. There was no evidence of acute or chronic inflammation; polymorphonuclear leucocytes were not present; fibroblasts were absent, and there was no increase in adult connective tissue. Although there was no inflammation there were small collections of lymphocyte-like cells but these were collected in groups and not scattered diffusely throughout the ganglia. In the ganglia removed from patients suffering from arthritis slightly less than 50 per cent contained similar small collections of these lymphocyte-like cells. There was a slight amount of edema in the ganglia, but it was localized, and varied greatly in the other ganglia removed for this condition. Special stains were utilized in studying the ganglion cells, and approximately two-fifths of the cells were normal, one-fifth of them manifested a mild degree of chromatolysis and a few cells were pyknotic. In approximately two-fifths of the cells there was vacuolization at the periphery and this corresponded to what seemed to be swollen endocapsular cells. This vacuolization was mild in most of the cells in which it was present but in a few cells it was quite prominent. The swollen endocapsular cells corresponded in situation to the vacuoles in the periphery of the ganglion cells. In an eighth of the ganglion cells pigment was not present in the cytoplasm whereas in three-fourths there was a slight amount of pigment (graded 1) and in the remaining eighth it was more pronounced (graded 2). The average age of the patients suffering from arthritis was 30.7 years. The average age of those whose ganglia contained pigment less than grade 1 was 19 years of those with pigment graded 1, 31.9 years, of those with pigment graded 2, 35 years and of the one patient whose ganglion cells contained pigment graded 3, the age was 53 years. These observations again support the opinion that pigment in sympathetic ganglion cells increases with age and is not necessarily a manifestation of the disease process.

SCLERODERMA

Scleroderma is sometimes alleviated by sympathetic ganglionectomy. The condition

of the skin is characterized principally by brownish discoloration associated with thickening or atrophy, usually involving the fingers and toes. The distribution may be circumscribed, spotty or diffuse, and limited to the feet and legs or it may involve the hands, arms, face and neck, and the skin over the upper part of the thorax. The muscles and bones may be included in the atrophic and degenerative process. The disease is usually slowly progressive and it occurs at any age or among persons of either sex but more frequently among young women. All cases of scleroderma do not result from disturbances in the sympathetic nervous system, but the lesions of the feet legs hands arms and face frequently are preceded by a phase of increased vasoconstriction characterized by cold, sweaty bluish hands and feet similar to those of Raynaud's disease(2). This type of scleroderma has been observed also in cases of thrombo-angitis obliterans and chronic infectious arthritis. The early cases of scleroderma associated with vasomotor changes, sometimes respond satisfactorily to operation on the sympathetic nervous system, but in advanced cases there is no marked improvement, because of the pathological changes that have taken place in vessels skin and subcutaneous tissues (8-17). The results in the early cases are those of immediate improvement in circulation and loosening and thinning of the skin over the extremities, face, and neck. The skin and muscles of the face lose their drawn expression the mouth can be opened more widely and the tongue can be protruded. The operation will not help in advanced cases in which thickening of the skin and hardness of the muscles have become extreme and therefore if operation on the sympathetic system is to be employed in the treatment of scleroderma of vascular origin it should be employed as soon as the disease is recognized in order to prevent its progress. If the condition is permitted to continue it usually results in pain deformity, and total invalidism.

In 16 cases of scleroderma of the vasomotor type operation has been done and sympathetic ganglia have been removed. The following case was selected from the group be-

cause of the history and definite improvement following operation. We have assumed that histological changes, if present should be discernible in the removed ganglia of successful cases.

Illustrative case. A woman aged 48 years, came to the clinic complaining of stiffness of the hands associated with thickening of the skin over the thorax and face. Her history revealed attacks of increasing severity in which on exposure to cold all of the fingers and toes first became white and cold then blue and finally red and warm. After many years these symptoms became more pronounced, and the skin of the hands, arms thorax and face began to lose its flexibility, resulting in retarded motion. Exposure to cold intensified all symptoms.

General examination was essentially negative except for the changes incident to the scleroderma. There was evident thickening of the skin of the face the wrinkles being ironed out, and definite limitation of motion on opening the mouth and protruding the tongue. The skin over the thorax had a definite sheen and could not be rolled under the fingers. The hands appeared waxy the fingers were stiff and permitted about 25 per cent flexion. The joints of the fingers were enlarged and tender to pressure and the hands were cold and moist.

Because of the evident association of vasomotor spasm and the failure of other types of treatment to control the progress of the disease, sympathetic ganglionectomy was carried out and the stellate and second thoracic ganglia were removed from each side (Fig. 1). As early as the seventh day following operation, a decided change in the facial expression was noted the normal pink hue had replaced the waxy appearance and the skin was decidedly softer. There was also a slight increase in skin temperature. The stiffness of the hands began to improve until by the fifteenth day after operation the skin of the fingers up to the first joints was normal in appearance. All the fingers were warm, but the mobility was not increased. The mouth could be opened wider and the tongue protruded farther.

One year and 10 months after operation the patient returned and her general condition was found to be excellent. There was definite improvement in the scleroderma of the hands, thorax, and face. The hands were warm and, although a little stiff had shown great improvement.

Slight changes were noted in the ganglia similar to those in the ganglia removed for the lesions mentioned already. Most of the arterioles and small arteries in the ganglia were normal, and in a few there was slight proliferation of the lining endothelial cells of the intima. There was no thickening of the walls of the vessels, and the normal ratio of wall to lumen was constant throughout. There was

no inflammation acute or chronic, and there was no increase of the connective tissue although there was a slight amount of edema, but this was not universal throughout the ganglia. It was present in less than 50 per cent of the cases. Although there was no inflammation there were small collections of lymphocyte like cells in the ganglia in this case but in the ganglia from the entire group it was present in only 30 per cent. In the ganglion cells themselves there was slight chromatolysis in a few approximately 25 per cent and in the entire group of ganglia removed from patients suffering from scleroderma chromatolysis was present to this degree in only 30 per cent. As in ganglia studied from all conditions there was vacuolization of the periphery of the cytoplasm of the cells and this corresponded to the swollen endocapsular cells. This proliferation corresponded in degree and site to the vacuolization of the cytoplasm of the ganglion cells. Pigmentation was visible in most of the cells, but was usually slight. It was present in the same mild degree in 75 per cent of the ganglia removed for this condition. The average age of the patients in the entire group was 35 years. In the cases in which there was no pigment the average age was 27.5 years, in the group in which pigment was graded 1 the average age was 37 years. Pigment was not graded more than 1 in any case. The finding of pigment in the ganglion cells supports the observations made in ganglia removed for the other conditions that there is a deposition of pigment with advancing age.

HISTOLOGICAL STUDIES OF NORMAL GANGLIA

The ganglia which we used as control material for this study were obtained at necropsy in 40 consecutive cases in which death had resulted from various causes. None of the patients had suffered from any of the four conditions which we have considered. We sought the same changes that we had looked for in the various conditions mentioned. Less than half the vessels were normal but the changes which were present were slight, and most of them can be accounted for on the basis of age. The walls of the vessels were slightly thickened in more than 50 per cent

of the subjects and in a few (one-eighth) there was proliferation of the endothelium lining the intima and as in the vascular conditions this was slight much slighter than is constantly seen in cases of severe or even mild hypertension. There was no sign of acute or chronic inflammation or increase in the connective tissue in the ganglia, occasionally the connective tissue was much looser in texture and slight edema was present this was probably the result of local inflammation which was present in several cases. Lymphocyte-like cells were present in small groups but less frequently than in any of the other conditions and this was the only observation which varied from those constantly noted in the ganglia removed in the other cases considered. The ganglion cells themselves showed changes similar in type and degree to those we observed in the other cases. Chromatolysis was present in a few ganglia, and cystic degeneration of several ganglion cells was also seen swelling of the endocapsular cells which corresponded to the vacuolization of the periphery of the cytoplasm of the ganglion cells was common. The most interesting observation was that of pigment in the ganglion cells. The various ganglia were studied the changes noted and the degrees of change recorded without any knowledge of the age of the patient or the condition from which he suffered. The age in the control series was higher than in any other series. The average age in the control series was 46.6 years. More material must be found before definite conclusions can be reached regarding the age at which pigment first appears. The average age of patients whose pigment was graded 1 was 43.7 years the average age of patients whose pigment was graded 2 was 56.9 years, and the average age of patients whose pigment was graded 3 was 64.7 years. There was, as in any control series, a marked variation in the individual cases, but nevertheless a marked tendency for the pigment to increase with age. This has been our observation for many years and coincides with that of others.

GENERAL COMMENT

In comparing the histological observations of the sympathetic ganglia, removed for the

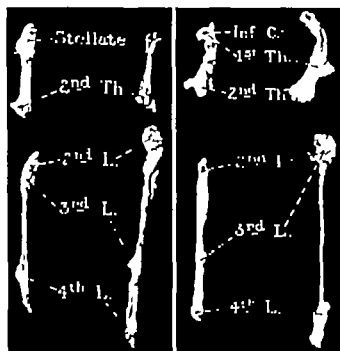


Fig. 1. Cervicothoracic and lumbar sympathetic ganglia removed surgically from cases contained in this series. The lack of uniformity in the anatomical distribution of the ganglia along the sympathetic trunk is well illustrated as well as the tendency for one or more ganglia to be fused.

conditions described with each other and with those of normal ganglia nothing was found to explain the various vascular disturbances. All the changes were within normal limits and most of them can be explained on a basis of advancing age. There was no histological difference between the ganglia removed for the various diseases although these varied much in their clinical manifestations. The blood vessels in the ganglia removed from patients with vascular diseases did not partake of the changes in the blood vessels of the diseased extremities and were similar in most respects to the control vessels. Small collections of lymphocyte-like cells were present in all the ganglia as well as in the control ganglia. These cells closely simulated lymphocytes and differential stains were of little positive value yet it is possible that they represented proliferated endocapsular cells replacing degenerated or disintegrated ganglion cells. In opposition to this possibility is the fact that they were not always enclosed in the capsule which normally surrounds ganglion cells although endocapsular cells surround the dendritic processes



Fig. 2. Marked variation of the degree of endocapsular cell proliferation may be noted. Swelling of some of these cells is present with erosion of their periphery with the formation of peripheral vacuolization. In one place, the proliferated endocapsular cell has replaced the ganglion cell and in another only a small remnant of the ganglion cell is seen, and this is pyknotic (toluidin blue $\times 350$).

of the ganglion cells. These cells were always in groups and not scattered diffusely throughout the ganglia. They were not associated with blood vessels which is frequently the case in inflammation of the central nervous system. Sympathetic ganglion cells are surrounded by a delicate capsule which is covered on the outside by a layer of flattened elongated cells of connective tissue origin and are referred to as ectocapsular cells whereas the inner side of the capsule is lined with a layer of cells which we have referred to as endocapsular cells and to which von Lenhossek gave the name 'amphicytes' and Cajal called 'satellite cells'. The origin of these endocapsular cells is not yet definitely established but we think that they are analogous to oligodendroglia, just as De Castro considers the analogous cells of the ganglia of the spinal nerves a type of neuroglia similar to Hortega's oligodendroglia rather than of mesodermal origin. In this way they simulate the satellite



Fig. 3. Endocapsular cell proliferation in one cell, with vacuolization of the periphery of the cell. In another cell, ectocapsular cell proliferation is demonstrated. These cells are flattened (hematoxylin and eosin $\times 335$)

cells of the central nervous system. Their reaction both in the normal ganglia and in those surgically removed is similar to the acute swelling of the oligodendroglia described by Penfield and Cone, and which have been shown to be analogous to the mucocytes of Grynfeldt. The swollen endocapsular cells of the sympathetic ganglia were surrounded by clear spaces similar to oligodendroglial cells. It is with the greatest difficulty that cell bodies belonging to these cells could be demonstrated even with Hortege's silver carbonate method. Cajal's gold chloride and sublimate method also failed to reveal cell bodies. None of the swollen endocapsular cells contained debris which had an affinity for silver indicative of phagocytic activities so that the indentations in the ganglion cells were not the result of phagocytosis. However mucus stains showed that some at least of the spaces around the endocapsular cells contained a slight amount of thin mucus. This was not constantly present but was seen with sufficient frequency to produce a simi-

larity to the mucocytes which Bailey and Schaltenbrand have shown to be acutely swollen oligodendroglial cells. In only a few ganglia these endocapsular cells appeared to be proliferated (Fig. 2). Even more rarely were the ectocapsular cells proliferated although in the few instances in which it had occurred it was quite definite (Fig. 3). Most of the large cysts which caused compression and frequently complete destruction of the ganglion cells contained abundant and easily demonstrable mucus. Some of the sympathetic ganglion cells had a ragged appearance (Figs. 4 and 5) thus we have referred to as vacuolization considered to be the result of the acute swelling of the endocapsular cells which occasionally contain mucus. This process may become quite pronounced and the vacuolization may produce marked reduction in the size of the cell body, simulating the corroded cells of the spinal ganglia, which have been described by De Castro (Figs. 4 and 5). In none of the ganglia which we have studied had it progressed to the degree described by De Castro, or led to complete disintegration of the ganglion cell. Around most ganglion cells in fixed preparations there is a definite clear space separating it from the cell capsule. This space varies much in different cells, and it appears to us to be an artefact due to shrinkage of the cell during the process of fixation. The presence of pigment granules in the cells of the sympathetic ganglion is recognized by all investigators, and it increases with age so that in elderly persons most cells contain numerous pigment granules. Our study of the sympathetic ganglion cells confirmed the observations of others that the pigment increases with age and that it is made up of two types, the lipochrome or fat containing pigment which stains with sudan III and the fat-free type which has an affinity for silver and is probably a true melanin pigment. Increase in the deposition of pigment in the body during the later decades of life is not limited to ganglion cells of the sympathetic nervous system but it increases in the ganglion cells of the central nervous system and in many other organs. In our study of the ganglion cells of the sympathetic nervous system a definite increase with advancing age

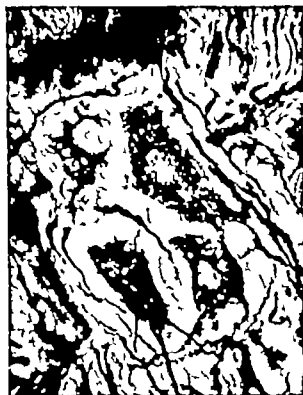


Fig. 4. A group of four ganglion cells, one of which is normal, one shows the effect of the capsular cell proliferation with the vacuolization of the cell body (silver impregnation $\times 700$)

was constantly noted and we feel that this has no connection with the disease process for which the ganglia were removed. Occasionally many bright eosin staining granules are intermingled with the pigment granules. The significance of these eosinophilic granules is not clear. With silver impregnation methods the outline of most ganglion cells appeared normal with their numerous processes extending in all directions into the surrounding tissue and neurofibrils appeared normal (Figs. 4 and 5). Occasionally ganglion cells were compressed by cysts which we have noted in consideration of the various cases and even the remnants of the compressed cells had a strong affinity for silver nitrate (Figs. 4 and 5). The same silver impregnation methods demonstrated the fact that axis cylinders were present in normal numbers and they seemed to be normal in outline and regular in their course and distribution.

These various observations lend support to the conclusion which has frequently been advanced, that the noxious agent causing the vascular diseases for which operative relief

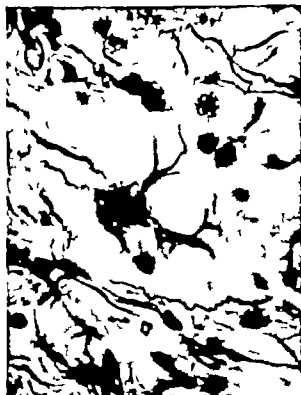


Fig. 5. This ganglion cell shows one large vacuole encroaching on its cell body. The nucleus of the swollen endocapsular cell which caused the vacuole, is visible (silver impregnation $\times 840$)

has been instituted does not act on the sympathetic ganglia removed. Since the removal of the sympathetic ganglia leads to improvement of the blood supply to the affected limbs it would seem that the ganglia act simply as relay stations for impulses from higher centers where the disease originates.

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STUDIES ON BRONCHIAL OCCLUSION BY THE METHOD OF ADAMS AND LIVINGSTONE¹

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THE absence of a safe and satisfactory method of occluding large bronchi has been a great handicap to the development of surgery of the lungs. The recent important experimental work of Adams and Livingstone in which bronchi were occluded by the local application of a 35 per cent solution of silver nitrate has possibly supplied a method which may be of vast benefit in the treatment of patients with pulmonary disease.

In attempting to repeat the work of Adams and Livingstone (2) in order to satisfy our own curiosity several difficulties were encountered that are being reported in this paper. In addition studies were performed under several experimental conditions that have not been investigated by them.

Dogs and cats were employed as the experimental animals. A 35 per cent solution of silver nitrate was used in all experiments. A small piece of cotton that had been placed on a bronchoscopic forcep was saturated with the silver nitrate and the application to the bronchus was made through a bronchoscope. Morphine was used as the anesthetic for the dogs and nembutal for the cats. Ether anesthesia unaccompanied by the injection of atropine was tried in some of the experiments but there was such a profuse secretion into the bronchus that the silver nitrate did not exert its effect.

Cats were used as well as dogs because the mediastinum of the cat is more rigid than that of the dog. Attempts were made to use rabbits which have a still more rigid mediastinum but due to the small size of the trachea, these attempts were abandoned. In the first group of experiments on both dogs and cats the death rate was high. Seven of the first 10 dogs died and 8 of the first 10 cats lived only a short while. Death frequently occurred within 48 hours following the application of the silver nitrate and it was usually associated with hemorrhage. The animals which died several days following the application showed at

autopsy a pneumonic consolidation of the lobe the bronchus of which had been cauterized. A similar appearance was noted in one dog that lived 15 days. In one dog that was killed 55 days following the application of the silver nitrate there were several rather hard areas in the lobe in question the neighboring bronchi were dilated and contained mucoid material. The rest of the lobe was air containing. In a cat that died 26 days after the application part of the lobe the bronchus of which had been cauterized was completely atelectatic while the remainder showed a pneumonic consolidation. In several of the animals one or more of the lobes were completely atelectatic as has been described by Adams and Livingstone. A photograph of the lungs of a cat which shows complete atelectasis of the left side is given in Figure 1. This animal was killed 27 days following the application of the silver nitrate.

The mortality rate has been very much lower in our subsequent experiments and we believe that the high rate in the earlier studies was due partially to the fact that we did not rid the cotton pledgets of the excess of silver nitrate. It seems likely that the pressure of the pledget against the bronchus squeezed some of the solution out of the cotton and allowed it to escape into the smaller bronchi.

Embohc lung abscesses were produced in 10 dogs by the method described by Holman, Weidlein and Schlueter. Two weeks later a 35 per cent solution of silver nitrate was applied to the bronchus of the affected lobe. Three of the dogs died several days following the application. The 7 remaining dogs were subjected to autopsy 6 weeks later. A residual abscess was found in 4 of the 7 dogs. The bronchus of the diseased lung was not occluded in any of the 7 dogs. In 2 animals in which the abscess was in the right lower lobe, the bronchus of the right accessory lobe was found to be occluded and the lobe was completely atelectatic while the bronchus of the diseased



Fig. 1. Heart and lungs of a cat showing complete atelectasis of left lung following the application of silver nitrate to the bronchus.



Fig. 2. Showing complete atelectasis of right accessory lobe. The right lower lobe is air containing and a small residual abscess is to be seen.

lobe was not occluded and the lobe was not atelectatic. A small residual abscess was present in the lower lobe in these 2 instances. The accompanying photograph (Fig. 2) shows the atelectatic accessory lobe and the non-collapsed right lower lobe of one of the dogs. A small abscess can be seen in the right lower lobe.

Adams (1) has recently found that the application of silver nitrate to the bronchus of a lobe containing an experimentally produced pyogenic abscess usually causes delay in the healing of the abscess. Our findings in this respect are confirmatory of his.

Intrapulmonary disease in the human is frequently associated with thickening and stabilization of the mediastinum, or adhesions between the visceral and parietal layers of pleura, or both. The condition of affairs in the chest of the normal dog is quite different and particularly so since the dog has an extremely thin and easily movable mediastinum. In order to try to render the chest of the diseased human and that of the dog more nearly comparable two types of procedures were performed. In 5 dogs, a portion of one of the lower ribs was removed and the right lower lobe was sutured in a number of places to the chest wall and the visceral pleura of the lobe was painted with mercurochrome. Two of the dogs died of empyema. After the incisions had

healed in the remaining dogs, silver nitrate was applied to the region of the right lower lobe bronchus. Six weeks later the animals were killed. There were fairly firm adhesions between the right lower lobe and the chest wall. The bronchus to the right lower lobe was not occluded. In one of the animals, the bronchus to the right accessory lobe was occluded and the lobe was atelectatic. In experiments on 4 dogs, an intercostal incision was made on the right side and the mediastinal pleura was painted with 3.5 per cent iodine. Two of the animals died of empyema. After the incisions had healed, silver nitrate was applied to the right lower lobe bronchus. The two animals were sacrificed and autopsied 6 weeks later. The mediastinum of each was thickened but was not absolutely fixed. There was no bronchial occlusion in either of the animals. We do not believe that these experiments are highly significant because the number of animals is small and because repeated applications of the silver nitrate would probably have resulted in occlusion.

Attempts were made to produce bronchial occlusion in puppies approximately 6 weeks old for the purpose of studying the alterations in the lungs after the dogs reached their full development. The mortality rate in these experiments has been very high. Most of the animals had severe paroxysms of coughing

Several of the puppies lived less than a week following the application of the silver nitrate. Death of 3 of the animals occurred 4 weeks, 5 weeks, and 6 weeks following the application of the silver nitrate. Clear fluid was present in both pleural cavities of 2 of these. There was complete atelectasis of the left lower lobe of one of the puppies while the 2 remaining showed a pneumonic consolidation without bronchial occlusion.

The output of the heart and the maximum and minimum blood pressure were determined in experiments on 3 dogs before and after the production of atelectasis of the left lower and the right accessory lobes. No significant alterations in either the cardiac output or the blood pressure were found. The occlusion of a greater number of bronchi would probably be associated with changes in the cardiac output and blood pressure.

SUMMARY

The method of Adams and Livingstone of producing bronchial occlusion by the local application of 35 per cent silver nitrate has been employed in experiments on dogs, puppies and cats. The extremely high death rate in the early experiments was probably due partially to the use of an excess of the silver nitrate solution. The dangers were lessened but not entirely eliminated by observing this

precaution. When the attempts at bronchial occlusion were successful the alterations in the bronchus and in the atelectatic lobe of the cats and puppies were similar to those that have been described by Adams and Livingstone for the dog.

Attempts at occlusion of the bronchus of a lobe that contained an embolic pyogenic abscess were unsuccessful. The abscess did not alter the ability of the silver nitrate to close the bronchus of an adjacent lobe. In the several experiments in which adhesions between the visceral and parietal layers of pleura had been produced and in those in which a thickening of the mediastinum had been caused by irritants the single application of silver nitrate did not result in an occlusion of the bronchus. The occlusion of the left lower and the right accessory lobes of dogs did not cause significant alterations in the cardiac output and blood pressure.

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CLINICAL SURGERY

FROM THE GRAND RAPIDS (MICHIGAN) CLINIC

SURGICAL MANAGEMENT OF LIP MALIGNANCIES

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THE initial small malignant lesions about the lips are simply and effectively managed either surgically or by some other destructive agent. The larger more advanced lesions, which do not require destruction of more than one third of the lip may be removed and the lip repaired without the introduction of foreign tissue.

Lesions requiring destruction of more than one third and possibly the total lip have been less boldly and frequently badly managed because the attendant had no satisfactory technique for a repair of the surgical defect.

Few if any of the operations described in texts for large partial or total lip reconstruction should ever be employed. Practically all of these operations contemplate the use of full thickness cheek flaps which are cut without regard for the muscles of expression about the mouth, or for blood and nerve supply. The included muscle atrophies in most instances and supplies only a scar filling which is without function.¹

Methods of reconstruction should be limited to those that conserve all function remaining after the lip destruction. frequently it is possible to restore the major function in the repaired part. It is never necessary to cut into the musculature about the defect. An entire upper or lower lip may be lined and covered from the vicinity of the defect with a minimum of visible scar. The cosmetic result under such circumstances will, obviously approach as near the normal as is possible in any surface repair.

Confidence born of the certainty of such restoration, will permit both the patient and the physician to attack the problem boldly and with greater hope of a successful solution.

SMALL LESIONS

The amount of tissue removed is determined by the size and character of the lesion. The lines of excision should be slightly curved so that

approximation will result in a small elevation of the lip border at the line of suture. This elevation prevents the formation of a notch in the lip border as the result of linear scar contraction.

LARGE LESION WITH AND WITHOUT METASTASES

The management of these lesions is completed in 3 stages: first, destruction of the lip lesion with or without block dissection of the neck; second, reconstruction of the lip; third, cosmetic corrections.

The first stage requiring block dissection, is performed under general anesthesia, utilizing either avertin or ether vapor. Those cases requiring only dissection of the submental and digastric triangles are operated upon under local anesthesia supplemented with sodium amytal or nembutal.

The lines of skin incision should be placed at least 1 centimeter on either side of the palpable borders of the lesion. These incisions are carried from the free margin of the lip to the buccal sulcus or as far beyond as the lesion requires. In those cases in which the lesion involves only the lip, the excision is completed by carrying a horizontal incision along the sulcus about 3 to 5 millimeters from the fornix.

The management of the borders of this excision must anticipate the reconstruction of the lip. To accomplish this, flaps for a lining to replace the excised mucosa for the outer skin covering and for the vermillion free margin, must be so planned that ample material enjoying an adequate blood supply is available.

The blood supply of the lining flap, which will be reflected from the skin adjacent to the angle of the mouth, must come from the buccal mucosa and the muscle bordering the incision. Consequently the mucosa on this edge must be undermined and accurately approximated to the skin with fine, closely placed horsehair sutures. This produces a minimum of scar and a maximum blood supply. This blood supply is usually

¹Verdebeck, Nelson: *Reconstructive Surgery*

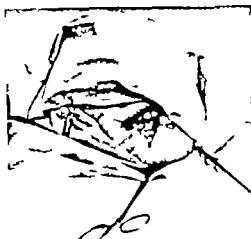


Fig. 1A.



Fig. 1B



Fig. 2

Fig. 1A Vertical mattress sutures of horsehair or ophthalmic silkworm gut are passed through the mucosa and muscle beneath the skin and are tied on the mucous surface of the lip. These sutures provide both approximation and relaxation.

Fig. 1B Detail of stitch.

Fig. 2 The skin is closed with horsehair which is replaced on the second day with gauze collodion strips to prevent stitch scarring. These supports should remain in place for ten days.



Fig. 3



Fig. 4.



Fig. 5

Fig. 3 Stage 1

Fig. 4 Stage 2

Fig. 5 The posterior margin of the mucosal flap is

sutured with horsehair to the free margin of the reflected lining flap and also to the mucosa in the angle of the mouth.

adequate but it can be guaranteed by outlining partially undercutting and reapproximating this skin flap at this stage (A Fig. 3)

The mucosa bordering the edge of the lip remnant is similarly undercut and sutured. This mucosa will be utilized to form the free vermillion border of the reconstructed portion of the lip (C Fig. 4)

The skin bordering the excision—chin or face and nose in the case of a lower or upper lip—is undercut and accurately approximated to the mucosal remnant along the buccal sulcus.

These suture lines are painted with compound tincture of benzoin until they are thoroughly sealed. A strip of gauze is fastened with collodion

to the cheeks on either side to limit movement. No other dressing is applied.

The flaps for the lining A and the covering B are outlined. They may be raised and sutured in their original locations at this time if the blood supply is questionable. The blood supply, however, is usually excellent.

The mucous membrane on the incised edge of the lip remnant is removed between two parallel incisions placed 1 centimeter apart. One incision is carried down its union with the skin and the other through the mucosa on the posterior surface of the lip. Its blood supply is formed by the mucosa on the free margin of the lip and a broad portion of mucosa posteriorly. This flap C held



Fig. 6 A, Perforating carcinoma creating a pathological harelip. B, Appearance of the lip 2 weeks after excision. The removal of the lesion included the tissue bordering the nasal ala. The defect has been closed by loosening the cheek tissues from the underlying bone and suturing to the base of the nose. C, Appearance of the lip 6 years after operation.

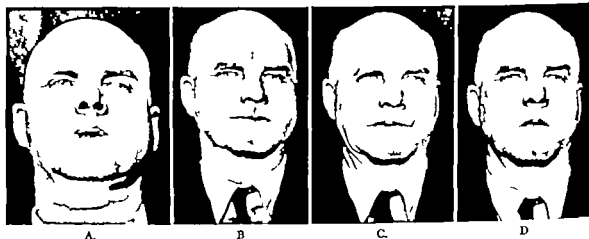


Fig. 7 Carcinoma of the mid-portion of the lower lip. A, Appearance weeks after excision of the lip and dissection of both digastric and submental triangles.

D The reconstructed lip. B and C, Demonstration of the muscular action which is now possible in the reconstructed mouth.

on the sharp hook, will form the vermillion border of the reconstructed lip.

The skin flap (A Fig 3) carrying underlying fat, is turned from the face on a "hinge" and sutured to the incised margin of the mucosa on the posterior surface of the lip remnant.

The covering flap (B Fig 3) is incised and elevated with the underlying fat.

The skin of the face on either side of the defect resulting from elevation of the covering flap (B Fig 3) is freely undercut and approximated with horsehair sutures. The approximation of these skin edges adds two-thirds of the width of the flap to its length.

The covering flap (B Fig 3) is rotated 90 degrees to cover the lip and the defect left by reflection of the lining flap (A Fig 3). The opposing skin edges are sutured with horsehair.

The anterior edge of the mucosal flap (C, Fig 4) is sutured to the free edge of the covering flap with horsehair.

The tent, (D Fig 5) created by the rotation of the covering flap (B Fig 3) is adjusted by the removal of excess skin and suture. This should not be done sooner than the twelfth day because of possible damage to the adequate blood supply of the transplanted flap prior to this time. Any other cosmetic defects are corrected at this period.

The suture lines about the mouth are painted with compound tincture of benzoin and those on the face and neck covered with a gauze dressing wet with alcohol.

All skin stitches are replaced on the second or third day with gauze collodion supports which are maintained a minimum of 10 days.

The lining of the lip which is formed by reflection of the skin from the face is annoying to male patients because of the growth of hair. This can be replaced after 60 days with normal mucous membrane from the cheeks. The repair is effected by multiple excision. Approximately one half the skin can be removed at the first stage and buccal mucosa advanced to fill the defect. Sufficient relaxation of the mucous membrane will again

occur at the end of 4 to 6 weeks to permit the excision of the remaining skin.

It is sometimes advisable to utilize flaps from both sides of the mouth in the construction of an entire lip. When this method is followed a long covering flap and shorter lining flap should be cut on one side and the reverse procedure practised on the opposite side. This will place the junction line of the covering flaps at a different point than the union of the lining flaps and prevent a depressed adherent scar line.

This plan of management permits the boldest attack on the local lesion and, at the same time provides a method of repair which is highly satisfactory from both functional and cosmetic standpoints.

FROM THE KASR EL-AINY HOSPITAL CAIRO

A TECHNIQUE OF TUBO-UTERINE ANASTOMOSIS (IMPLANTATION) IN INTERSTITIAL AND ISTHMIC OCCLUSION

AHMED SILAFEEK M.B. B.S. (LOND.) F.R.C.S. (ENG.) CAIRO, EGYPT
Gynecological and Obstetric Surgeon to Kasr El-Ainy Hospital

TUBAL implantation if it should at all serve the object for which it is done must be planned so as to give the utmost uterine security both during pregnancy and labor. It should not disturb the normal anatomy by injuring the musculature of the uterus or its cornual sphincters.

It should as well aim at conserving the salpingo-uterine continuity permanently. Mere implantation into the uterine cornua and the bringing together of uterine and tubal mucosa (end-to-end union) is insufficient. Even if permanent permeability is thereby attained the line of junction might become constricted which would defeat our object.

INDICATIONS AND CONTRA INDICATIONS

The choice of cases for implantation cannot usually be definitely decided beforehand as we cannot foretell whether or not sufficient tubal length will be available. It is therefore clear that abdominal exploration is necessary even if tubal implantation is not found feasible. We would then be able to liberate adhesions, resect any diseased part of the ovary or the tube or correct the uterine position if any of these conditions is present.

Tubal implantation is indicated under the following circumstances:

1. In the presence of sterility with interstitial blockage that shows no evidence of any actual adnexal inflammation.

2. Or in cases in which there had previously been adnexal inflammation which had been relieved and there had been no recurrence for a sufficiently long period, i.e. about a year's time.

Pre-operative hysterosalpingography should always be done preferably not less than a week

beforehand. A course of treatment with tampons and douches is done afterward to alleviate any irritation caused by the manipulations or the lipiodol. Implantation would naturally have no place in cases that show definite uterine infantilism or atrophy or in cases of ovarian hypofunction whether primary or secondary to the chronic pelvic inflammation and adhesions. Restoration of anatomical and functional permeability fulfills no object in such cases.

STEPS OF THE OPERATION

The usual vaginal toilet is carried out.

The cervix is dilated to the size of a No. 8 Hegar dilator so that a Bonney insufflator can be inserted without any leakage. The insufflator is left *in situ*.

Abdominal operation. The adhesions are liberated. The uterus and adnexa are delivered through the wound. A sound with a bulbous end is introduced into the abdominal opening of both tubes to determine the extent of their patency and to obtain a clue as to where we should cut the tube across—that is at its innermost permeable point (Fig. 2). We should require at least 6 centimeters of fallopian tube (ampullary and isthmal) for efficient utilization.

The isthmal tube which is the part usually blocked, is liberated from its mesosalpinx up to the cornu where it merges into the short interstitial part (Fig. 3). At this junction and with a conscious preservation of the cornu in its entirety a circular incision through serosa and muscularis is made until we encounter the fibrosed impermeable core that remains of the interstitial mucosa. This core with its continuation in the interstitial tissue is patiently and gently dissected

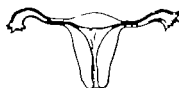


Fig. 1



Fig. 2

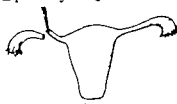


Fig. 3

Fig. 1: Drawing showing occluded area in tube.

Fig. 2: Drawing showing the innermost permeable point.

Fig. 3: The isthmal tube is liberated from its mesosalpinx up to the cornu.



Fig. 4.



Fig. 5



Fig. 6



Fig. 7

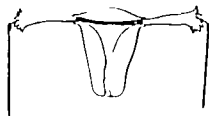


Fig. 8



Fig. 9

Fig. 4 Careful dissection enables us to conserve the muscular integrity of the cornua

Fig. 5 Fenton dilator inserted in both tracts at same time

Fig. 6 Two catgut sutures have been passed through the whole thickness of the inner ends of the cut tube

Fig. 7 The suture is being carried out through cornu

uterine fundus, the other cornu to opposite tube and out through abdominal incision

Fig. 8 The sutures have been pulled through in opposite directions so that the inner part of each cut tube is telescoped entirely into the respective cornu to the degree required

Fig. 9. Later step in procedure.

out from the cornual musculature with a fine knife. If it cuts through as frequently happens the whitish spot that represents its continuity serves for further dissection until we open into the cone of endometrium that lines the uterine angle. The dissection is made much easier by the utilization of the Bonney or other insufflator to distend the uterine cavity and thus to bring the endometrial apex of the cornu farther out. The opposite side is treated in a similar manner and a small dilator is inserted in the opening already made when the insufflator is again manipulated. By this patent dissection we are able to conserve the muscular integrity of the cornua (Fig. 4).

The fine tracts left are then gradually sufficiently dilated by means of the Fenton dilators the dilators passing through both ends at the same time to admit the passage of a whole thickness of the tube (Fig. 5). Two catgut sutures are passed through the whole thickness of the inner ends of the cut tubes on both sides and are tied (Fig. 6). The sutures are then passed through the eyes of two rather long probes which are guided, in opposite directions through cornu uterine fundus the other cornu to the opposite tube and out of the abdominal ostium together with the sutures which are delivered out of the same tract (Fig. 7). The sutures are then pulled upon in opposite directions with the result that the inner part of each cut tube is telescoped entirely into the respective cornu to the degree required (Figs. 8 and 9).

In cases in which the tube on one side is found to be totally disorganized or its patent part so short as not to be utilizable the sutures placed on the cut end of the other effective tube are made to pass on a needle through the cornual hole and pierce from within outward the corresponding walls of the fundus about its middle line (Fig. 10). These sutures are pulled upon sufficiently to telescope the required length of whole tube inside the cornu.

Interrupted seromuscular sutures are inserted to unite cornu to tubal wall and thus firmly anchor it in position.

Tubo-uterine continuity is thus assured by these steps and a sufficient amount of the entire tube is invaginated into uterine cornu. The trans-uterine and tubal lengths of catgut left *in situ* further help to secure the permanency of this continuity as they remain there for some 40 days. Sterile oil or homenol if available is put in to prevent adhesions. After the operation the uterus is usually in a good position and the posi-

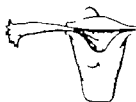


Fig. 10. Technique in case one tube alone is available for implantation.

FROM THE KASR EL-AINI HOSPITAL CAIRO

A TECHNIQUE OF TUBO-UTERINE ANASTOMOSIS (IMPLANTATION) IN INTERSTITIAL AND ISTHMIC OCCLUSION

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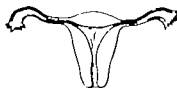


Fig. 1.



Fig. 2.



Fig. 3.

Fig. 1. Drawing showing occluded area in tube.

Fig. 2. Drawing showing the innermost permeable point.

Fig. 3. The isthmal tube is liberated from its mesosalpinx up to the cornu.

ADVANTAGES

The advantages of this operation which we have been doing for the last 3 years at Kasr El Ainy, lie, primarily in the maintenance of the muscular integrity of the uterus. The object of the operation is to reinstate tubo-uterine permeability in an effort to overcome this cause of sterility. And it is our belief that a uterus treated as we have described, with the musculature left intact, is better fitted to stand the strain of pregnancy and labor than is a uterus in which the cornua have been incised, cored-out or resected.

The advantage of the special way by which the tube is implanted in order to secure permanent continuity in its normal direction is evident.

There are two theoretical drawbacks to methods of operation in which the tube is not implanted in its natural site namely (1) the fertilized ovum is then implanted lower and (2) during periods of muscular atony the menstrual fluid may easily be regurgitated and this might lead to the occurrence of pelvic endometriomata.

The appended hysterosalpingograms demonstrate the integrity of the musculature of the cornua of the uterus. They were taken immediately after the injection of the lipiodol, while

screening. The conformity of the uterine cornua with the normal shape is well seen.

My thanks are due to Prof. R. S. Dobbin for encouraging me to make this study and for allowing me to use the French literature in his possession to my colleague Dr. H. Sobhy, obstetric tutor who has done the operation himself several times to Drs. Ahmed Marey and Hussein Erian for the radiograms and to Mr. Strelakovsky the artist to the Faculty for the execution of the drawings.

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Fig. 3A.



Fig. 3B.



Fig. 3C.



Fig. 3D.



Fig. 4

Fig. 3 Complete immobilization of arm. Advancement of pectoralis major and latissimus dorsi. Thick split grafts only possible method of covering defect. A, Arm grown solid to body with excessively thick scar over entire side. Deep dirty sinus running high toward axilla, 3 1/4 years

after burn. At the first operation the sinus was simply opened and then scabificae packs were kept on the raw area. At the second operation the contracture was opened widely but the arm would not come up satisfactorily. In consultation with Dr. C. H. Crego it was decided to ad-



Fig 5A



Fig 5B



Fig 5C

vance the pectoralis major and latissimus dorsi upward on the chest wall, and this was done without disturbing the nerve supply and without exposing the contents of the axilla. The muscles were anchored with catgut and the arm could be raised to the vertical. It was necessary to stop the procedure, and the area was dressed with acril flavine gauze. At the third operation (done 48 hours later) the entire area was covered with thick split grafts and the arm fixed with the dressing as described in Figure 1. Accurate measurement of the skin removed from the thigh showed five large areas and one small one, and the total area denuded 173 square inches (1,081 square centimeters). These grafts "took" successfully and good function and free movement up to about 105 degrees abduction were obtained.

At the fourth operation the contracture was opened low across the axilla, and one was opened just above the elbow. The resultant defects were covered with thick split grafts from the thighs. Three denuded areas on the leg measured 48 square inches. Total for both operations of 221 square inches (1,381 square centimeters). The final surface area covered as measured with a paper pattern shows less than one-half this amount. This is not an accurate measurement of field contracture, but rather an index of the large amount of graft one should have to cover one of these areas adequately.

B, C, and D. There is practically complete function, and the power of the pectoralis major and latissimus dorsi has been maintained (see Fig 4). In D along the posterior edge, note the small triangular inset of graft that allows important relaxation. The thighs show the rather inconspicuous scars of the thick split grafts, and in time another "crop" of grafts can be cut from these same areas to cover the heavily scarred flank if it gives too much discomfort. In B the scars of a few small deep grafts (done before entry to this service) can be seen.

This boy is an ideal type from which to cut thick split grafts by means of the suction retractor. The thighs are large and firm, and not too muscular. In a smaller child with a deformity of comparative size it might be a difficult matter to get adequate grafts for the covering of the defect.

Fig 4. Physiotherapy. Function. Same patients as shown in Figures 3 and 7 in the gymnasium of the Physiotherapy Department at Shriners Hospital. It seems that postoperative stiffness and even second contractures in these cases may be easily overcome if a will to help themselves is instilled in the patient and simple equipment is supplied for exercise and play. A trapeze hung in a transept of the hospital or home may suffice. Massage and baking and baths are seldom necessary if the restoration has been adequate and the patient is able to exercise. Function to be complete should, of course, permit complete motion of the arm, but in some instances, if the arm is gotten to above right angles by one operation, it may be difficult to get the patients to submit to further procedures because they do not feel that they have enough deformity to warrant it.

Fig 5. Comparison of full thickness and thick split grafts. Breast function and position. A. Arm grown firmly to side, complete destruction of axillary skin, widespread loss on chest, 1 year after burn. B. The deformity was released and the defect covered with a single full thickness graft that included almost the entire lower abdominal skin. C. About 1 year later some limitation of motion remained along the anterior axillary fold. This area was opened, and the defect covered with thick split grafts to give the result shown here taken still a year later. At this time it was impossible to distinguish the full thickness from the thick split graft. The white area is spontaneous healing that has occurred over areas of fairly deep loss. The breast may be elevated out of position, and, if possible, the original operation should correct this by relaxing it and grafting the defect. It may occasionally be pulled down if there has been heavy scarring over the flank and abdomen, and a separate operation and graft may be necessary for elevating it.

If the nipple area has been destroyed and there is heavy scarring over the breast tissue, it is our belief that the gland tissue atrophies and never regains its function. We have never seen any trouble with the breasts whether just heavily scarred or whether the nipple area itself has been destroyed, but pregnancy has not occurred in any patients of this series, and so the observations are not complete.

SUMMARY OF CASES

Type and age in years	Duration of lesion healed or unhealed	Type of graft used	Flap or graft across apex of lesion	Function, scars grafted No. of operations
3	6 mos Healed Extreme deformity	Full thickness	Graft No flap available	Both folds, arm, apex. Complete function One operation
5	4 yrs Healed	Full thickness	Graft No flap available	Both folds, arm, apex. Complete function. One operation
6	yr Healed	Full thickness	Graft No flap available	Both folds, arm, apex. Complete function One operation
6	1 yr Unhealed because of added X-ray burns	Full thickness	Graft No flap available	Anterior fold, arm and chest to let breast down in place. One operation
6	10 mos Healed	Full thickness	Flap from behind for apex	Both folds, arm, chest Not complete elevation but only one operation done
5	6 mos Healed Marked deformity and itching	Full thickness	Graft No flap available	Both folds, arm, chest, and apex Complete function. One operation
	6 mos Widespread keloid and itching	Full thickness and thick split to cover partial loss of full thickness	Local flap	Abduction gotten from 5 to 90 degrees Secondary operation refused
	yr Unhealed Solid growth to side	Full thickness follows 1 yr. by thick split	Graft No flap available	Both folds, arm, chest, apex Complete elevation operations
	yr Healed	Full thickness	Graft No flap available	Anterior fold and apex Complete function One operation for each side
9	mos Heavy keloid, intense itching	Full thickness right and left	Neither necessary	Anterior folds and chest. Complete function and flap operation necessary on left
	5 mos Marked deformity from debilitation of the 2nd cervical vertebra fractured at the time of the burn Neck and axilla unhealed	Thick split	Anterior fold, apex Breast let down with thick split grafts	Function perfect. One operation, breast down in normal position. Vertebra reduced by Dr. Tamm Brethren
6	yr Healed Had many small deep grafts, itchy healing best (almost correction of deformity)	Thick split	Local flap	Anterior fold, chest, arm Two operations Complete function
28	mos Whole chest and right axilla one painful ulcer	Thick split	Neither necessary	Whole anterior chest wall Anterior fold 3 operations. Complete function
3	mos Unhealed Very widespread, body chest, neck, arms	Thick split	Local flaps	Arm, chest, anterior fold operations Complete function
	6 yrs Good etc Only slight limitation of function Had operations that only scarred the webs further	Thick split	Local flaps	Chest, anterior fold, arm One operation Complete function
3	Several yrs Healed	Thick split	Local flaps	Chest, anterior fold, arm One operation Complete function
23	6 1/2 yrs Electric burn. Extreme deformity almost above but with only slight web in both axillary folds	No grafts necessary	Local flaps	Anterior fold apex flap operation One operation Complete function
3	yr Deformity both folds, itching and pocketing	No grafts necessary	Local flaps	Both folds and apex flap operation One operation Complete function
3	11 yrs Arm bound to side. Wide scarring	No grafts necessary	Local flaps	Both folds and apex flap operation. One operation Complete function
6	yr Several operations Almost relief of deformity	No grafts necessary	Local flaps	Anterior fold apex flap operation Complete function
3	16 yrs Arm solid to body with deep dirty pockets Extremely thick scar over whole side of body	Thick split	Thick split grafts and scar flap from the chest for ant fold. No distant flaps available	Both folds, apex, arm, chest, and back. Pectoralis major and latissimus dorsi taken, extruded from their origins and advanced toward axilla 4 operations. Over 200 square inches of skin used. Complete function obtained
9	1 yr Healed	Thick split	Thick split No flap available	Anterior fold, chest, apex, arm operations Complete function

SUMMARY OF CASES—Continued

Types are in years	Duration of lesion healed or unhealed	Type of graft used	Flap or graft in axilla	Function areas grafted No. of operations
1 7	2 1/2 mos. Unhealed	Thick split	Thick split No flaps available	Anterior fold, arm, apex best. One operation. Complete function
1 4	mos. U healed	Thick split	Thick split No flaps available	Flank, anterior fold, arm, chest. One operation. Complete function
15	3 yrs.	Thick split	Thick split. No flaps available	Both folds, per., best 1. let area 1 down flank. One operation. Complete function
1 5	6 mos. Extreme deformity, right, and left. Back heavy keloid. Child unable to protect self in falling.	Thick split	Thick split. Tried 1 turn flaps but they were not sufficient	Both folds, per., arm, chest. Both right and left sides. Three operations. Practically complete function
	3 yrs. Healed. Arm bent at side	Thick split	Thick split grafts. No flaps available	Both fold, arm, chest, per. One operation. Complete function
1 8	37 mos. Healed. Extreme deformity. Dislocation cervical vertebra. 1 time of burn	Thick split	Thick split grafts. No flaps available	Both folds, arm, chest, apex. One operation. Complete function. Also had reduction of dislocation by Dr. Theo. Brooker
1	7 1/2 yrs. Still ulcerated in one area. Had 7 operations that did not relieve the deformity and that ruined most of the donor area for getting graft	Thick split	Thick split grafts and local flaps	Both folds, per., arm, chest. Two operations. Complete function
7	10 wk. Very widespread severe burn. Cleaned up for operation in salt bath and with dry heat	Thick split	Thick split grafts. No flaps available	Both folds, apex, chest, flank. 2 operations. Complete function
5	6 mos. Heavy scar and painful keloid	Thick split	Local flaps	Graft, arm, both folds, best. One operation. Complete function
7	4 mos. Unhealed. Had one unsuccessful graft elsewhere	Thick split	Local flaps	Grafts, arm, both folds, chest. 3 operations. Complete function
4	6 1/2 yrs. Electric burn. Extremely heavy scarring, keratosis, and discomfort. U healed after 6 1/2 yrs. Microscopic diagnoses: squamous cell carcinoma	Thick split	Grafts in per. Flaps from front and back folded around arm	Grafts, chest, back, arm, both folds, apex. operations. Function almost normal. B t result blotted by removal of carcinoma that occurred over flank
7	4 mos. Unhealed. Extreme deformity pain, itching, and contracture	Thick split	Graft. No flaps available	Grafts, flank, abdomen. Both folds, per., arm. Arm free but repair unsatisfactory
4	4 mos. U healed	Thick split	Grafts. No flaps available	Arm free but repair unsatisfactory. operations

NOTE.—The term apex is used to designate the uppermost part of the axillary fossa as seen from the outside, and not as the anatomical apex of the base of the axilla.

The "Type" indicated in Column "One" is for convenience in classification of the deformity.

Type 1. Heavy local scar with bending or direct growth of the arm to the side.

Type 2. Heavy scar or keloid formation over the chest, back or flank, involving one axillary fold and possibly the per. of the axillary fossa.

Type 3. Web formation of one or both folds.

Fig. 6. Thicknesses of skin grafts. Shows relative thickness of Ollier Thiersch and thick split grafts taken from the inside of a man's thigh. There is a fair thickness of derma attached to the thinner Ollier Thiersch graft, and we have found that even thin grafts are rarely cut through or above the papillary layer as is the rather prevalent idea. They are usually cut just below the papillary layer and the bleeding that follows is from the derma rather than from the papilla. The thick, split graft does not look as thick as might be expected. This, however, was cut through a low level of the derma, but the derma itself was not very thick. This graft roughly includes about three-fourths of the thickness of the derma.

The thickness of the derma varies in different parts of the body on different people, in different ages, and in the two sexes. On the back the epithelium is very thin, but the derma is so thick that the growth of full thickness grafts taken from it is questionable.





Fig. 7A



Fig. 7B



Fig. 7C



Fig. 7D

Fig. 7. Wide chest, neck, and arm involvement. Local results of and scars of donor area of pinch grafts. A, Complete healing with the aid of pinch grafts one year after burn. There has been wide destruction over the chest, and the breast and nipple are entirely destroyed. The arm is held in by the bridge of scar tissue and grafted surface from the chest. B, This web was opened and no tissue was excised except the ulcerated edge. There was marked immediate retraction of the flaps and the large defect was covered with thick split grafts. A small graft was put in at a second operation when the neck was grafted. Full range of motion has been gotten (see Fig. 4). C, The wide degree of retraction following a simple opening incision is seen by the line of old pinch grafts on the arm, and the line of them far over on the chest. Before operation, as seen in Figure 7A, these grafts were all in the same area over the anterior fold. D, Scars of pinch, or small deep grafts done elsewhere after 1 year's time. Scar of thick split graft after 3 months on inside of right thigh.

Fig. 8. Utilization of both sides of a web. A Patient with burn scars of 16 years duration. The limitation of motion of the arm was not bothering the patient at all, and

he sought treatment only because the limitation from the web about the elbow interfered with his work. At operation the axillary web was split in two as outlined, and, without the excision of any surface tissue at all, the retraction of the scarred tissue (which was perfectly soft) was so great that the grafts outlined in C were needed to close the defect. At the same time the web from the arm to the forearm was split and all of it utilized in the closure, but here also it was necessary to use a graft to close the defect, and the graft healed in better than the flaps. Flaps of scar tissue cannot be cut very large or very thin without damaging their vitality. In this case it seemed improbable that grafts would be necessary but on opening the webs there was immediate retraction of the flaps. It is best not to put any tension on these flaps, and this point is emphasized here by the evident looseness of the skin around the elbow in C. In 4 cases out of the series of 35 good enough flaps were gotten so that no grafts were necessary. B, Shows relief of contractures in the axillary fold and in the cubital fossa. C, Grafts outlined. Note the different degree of pigmentation of the grafts—white on chest where it is stretched, dark on arm where all surrounding skin is lax.



Fig 8A

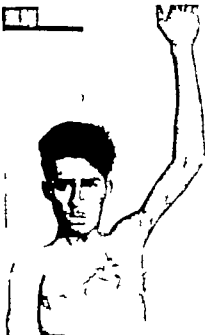


Fig 8B



Fig 8C

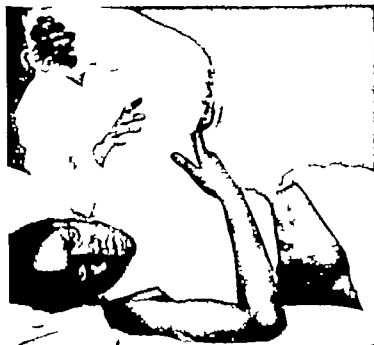


Fig 9A



Figs. 9B and 9C.

Fig. 9. A Plaster-of-paris cast to support arm. This type of fixation is not necessary and may even be detrimental if there is slipping or twisting of the body inside the cast. B and C, Fixation with a folded bed pad incorporated in the external layers after a firm sea sponge pressure dressing has been applied. This type of fixation is more

comfortable, much more easily applied and with it the patient can sit up without support and be out of bed. It is also much less expensive. The pad is folded in three or four layers and bound firmly on and held with several strips of adhesive. Most of the time the arm should be supported with extra pillows.

surfacing the raw areas the arm being fixed in abduction.

6 The use of large split skin grafts in sufficient number is a simple and almost universally applicable plan of surfacing these areas.

In the treatment of deep burns about the arm and shoulder free movement is the ultimate objective and the earlier this can be made the dominant note the better. With the general condition comfort and morale of the patient all being cared for the most important step in a recent burn is early complete resurfacing of the denuded area. This will shorten invalidism and lessen or prevent further fixation by the scar that occurs with spontaneous healing (Fig. 1)

During the period devoted to general pre-operative care the raw areas will contract and partially epithelialize by ingrowth from surrounding skin areas and possibly also from persistent remains of skin glands. Areas that heal from skin remnants may require no further treatment because the full thickness of the derma has not been destroyed but epithelialization by ingrowth (or seeding) from surrounding skin is for a long time extremely delicate and easily destroyed and the scar upon which it rests may subsequently have to be shifted or removed to allow free movements.

Even the most severe deformities including union of the arm to the chest wall can be relieved by division and dissection that permits the fullest relaxation with complete abduction of the arm. The dissection must be carefully done to avoid injury of the deeper structures, and complete abduction must not involve ruthless rending of underlying muscles. Concurrent grafting is done with the arm held at a right angle to the chest which position is maintained until the healing is completed (Figs 2 3 4)

Skin consists essentially of a thick, elastic, deep layer with a thinner protective covering. Derma normally rests upon a yielding base and epithelialized scar is a very poor substitute for normal skin and subcutaneous tissue when this scar is thick and unyielding. It is an encumbrance. When lost over a large area, normal skin is best substituted for in most cases with free grafts of split skin of a thickness greater than that of the Ollier Thiersch graft as it has usually been described. The thick split grafts should be of sufficient size to cover the whole area with one or as few pieces as possible. (Fig. 6.)

When this thick split graft is smoothly fixed to an even firm surface by suture and pressure it can fulfill the highest possibilities, but when the surface is uneven a full thickness skin graft may give a better appearance, this point, however, is

usually not of importance when the area is covered by the clothes. For a comparison of the technique and uses of the split and the full thickness graft, see references 1 and 2 (Fig. 5.)

Under split grafts there is always some contraction of the base on which they are put, but there is great power in the arm and shoulder actively to resist contraction and, because of this, the split graft is well adapted for covering defects here.

In cases of long standing with the fixation over a limited area the abductor muscles may have drawn out the scar into one or more soft webs, or plicae which permit free movement. In these cases operation is done chiefly to do away with the webbing. The fold is split and each side is converted into an appropriate flap by incisions that may somewhat resemble a Z. There were 4 such patients in this series. (Fig. 8.)

In 11 of the cases axillary flaps from neighboring skin or soft scar were used in conjunction with split free skin grafts as an extra protection for the axillary vessels and nerves, but, with care, we have so far succeeded in not exposing the axillary contents during the mobilization. In the late healed cases there was usually an increase in the quantity of fat, as happens everywhere that the depth of a natural surface fossa has been lessened by the traction of overlying or neighboring scar.

Treatment of one of these cases is difficult in many ways and well planned surgery of proportionate magnitude will usually prove a saving of both time and effort. On account of the general condition the scarcity of available skin or for some other reason pinch grafts, small deep grafts, small Thiersch grafts, implantation grafts, or tunnel grafts might be advantageously used to tide over some phase of the treatment, but these are not always conservative of the donor area. Homografts might be considered with these mentioned because, at times, they apparently stimulate subsequent spontaneous epithelialization but in our own cases we have not observed the homograft itself to persist. (Figs. 1 2 3 7)

Releasing scars and allowing the defect again to contract but adds to the total amount of scar (Fig. 8)

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CANNULA GASTROSTOMY AND ENTEROSTOMY¹LESTER R. DRAGSTFDT Ph.D. M.D. H. E. HAYMOND M.D. AND JAMES C. ELLIS M.D. CHICAGO
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THE production of an artificial opening through the abdominal wall into the stomach or intestine was attempted early in the history of surgery and a great deal of ingenuity has been displayed in the various operative procedures employed. These have been described so thoroughly by R. W. McNealy (1931) that no reference need be made here to this extensive literature. Attention has been directed to the development of simple methods whereby nutrient materials and fluids might be introduced directly into the stomach or intestines at will and yet prevent the escape of the highly irritating digestive secretions which produce such a troublesome excoriation of the surrounding skin. Not only has the operation of gastrostomy and enterostomy been of great service in the clinical treatment but it has been a most useful tool in the hands of the experimental physiologist in the study of digestion. It is the purpose of the present communication to describe a technique embodying the principles of one of the older experimental methods with certain modifications which has been useful to us both in the clinic and in work on lower animals and which in certain features seems to be an improvement on methods in current use.

The essential apparatus consists of a brass tube or cannula with certain accessories all heavily plated with gold throughout. Its shape is best appreciated by inspection of the accompanying photographs and drawings. The cannula with the circular flange is used for the production of a gastric fistula. The curved rectangular flange is designed for the small intestine. The introduction of the cannula is quite simple. An incision is made in the viscus (stomach or intestine) just large enough to admit the flange of the cannula. Closure is made with a running stitch and two purse string sutures to invert the mucosa snugly about the shaft of the cannula. The greater omentum is now carefully wrapped about the shaft and secured in place by several sutures. This step is most important, since it seals the fistulous tract from the general abdominal cavity and thus prevents a peritonitis. It represents an adaptation of the principle utilized by London (1927) in his

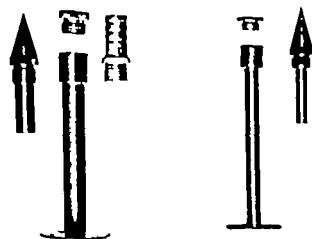


Fig. 1. Photograph showing the gold plated cannulas and accessories. Dimensions of the gastrostomy cannula to the left: total length 10 centimeters, inside diameter 1.20 centimeters, diameter of circular flange .4 centimeters. Dimensions of enterostomy cannula at the right: total length 10 centimeters, inside diameter .80 centimeters, length of flange 3 centimeters, width of flange 1.5 centimeters.

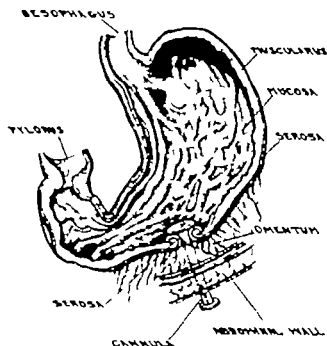


Fig. 2. Drawing illustrating the use of the cannula for gastrostomy. Attention is directed to the layers of omentum interposed between the stomach and the anterior abdominal wall.

¹ This work has been conducted under grant from the Douglas South Foundation for Medical Research of the University of Chicago.



Fig. 3

Fig. 4

Fig. 3. Patient T. N. Carcinoma of esophagus. Cannula gastrostomy June 10, 1931. Photograph taken July 15, 93, about 5 weeks later.

Fig. 4. Patient T. N. Carcinoma of esophagus. Cannula gastrostomy June 10, 1931. Photograph taken September 10, 1931 about 3 months later.

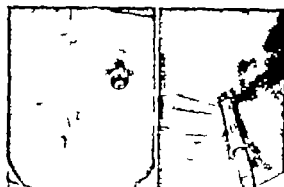


Fig. 5

Fig. 6

Fig. 5. Patient J. M. Carcinoma of esophagus. Cannula gastrostomy October 1, 1931. Photograph taken December 5, 1931 about 2 months later.

Fig. 6. Patient S. F. Carcinoma of esophagus. Cannula gastrostomy January 20, 1932. Photograph taken February 18, 1932 about 3 weeks later.



Fig. 7

Fig. 8

Fig. 9

Fig. 7. Patient E. F. Carcinoma of esophagus. Cannula gastrostomy April 16, 1932. Photograph taken May 3, 1932, 17 days later.

Fig. 8. Patient P. S. Carcinoma of esophagus. Cannula gastrostomy April 15, 1932. Photograph taken May 10, 1932, 25 days later.

Fig. 9. Photograph showing the absence of corrosion about the cannula used for a Pa. lev. pouch fistula in a dog, duration 8 months.

angiostomy experiments on lower animals. The distal end of the cannula is now brought through the abdominal wall by means of a stab wound, preferably 2 or 3 inches from the abdominal incision. To facilitate its passage through the abdominal wall and to secure a tight fistula a sharply pointed cap may be screwed to the distal end of the cannula. This is, of course, immediately replaced by the blunt cap or the rubber tube adapter for convenient syringe feeding. It is advisable to wrap a gauze strip about the protruding shaft until the stomach and omentum

have become firmly adherent to the abdominal wall. Patients experience surprisingly little inconvenience from the cannula and have no difficulty in the introduction of semi-solid food and fluids. There is no leakage, no excoriation of the surrounding skin, and hence no necessity for the constant changing of dressings.

To date we have employed this technique for the production of a gastrostomy in 6 patients suffering from carcinoma of the esophagus with stenosis. The legends accompanying the photographs give in sufficient detail the histories in these cases.

A more rigid test of the method has been secured in its use for the production of various types of gastric and pancreatic fistula in lower animals. Under these conditions a much more irritating fluid is drained away and a satisfactory adjustment of dressings cannot be obtained. Nevertheless during the past 4 years it has replaced other

methods in our laboratory, as incomparably more convenient in affording water tight fistulae for the quantitative collection of secretions and in its complete freedom from digestion of the skin of the abdominal wall. Here again the accompanying photographs best illustrate the technique employed

LEIOMYOMA OF THE JEJUNUM

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BENIGN tumors of the small intestine are sufficiently rare to deserve reporting. The series of cases from The Mayo Clinic reported by King in 1917 contained only one benign tumor of the small intestine in more than 44,000 cases in which laparotomy had been performed and Mallory in 4,165 postmortem examinations found only 11 such tumors.

The types of benign tumors found in the small intestine are polyp (adenoma), lipoma, fibroma, myxoma, myofibroma, myxofibroma, myoma,

neurofibroma, angioma, endothelioma, and teratoblastoma (5, 13, 20). The relative frequency of the different types is still in doubt. Polyps are said to be the most common (5) but the probable tendency of these tumors to disappear spontaneously (1, 2) in some cases and their definite relationship to malignancy (17, 20) make their classification somewhat uncertain. Of the other benign tumors, lipomata, myomata, and fibromata are the most common; the remainder are extremely rare. Despite the report of King that myomata occurred in his series more frequently than lipomata (45 of the former and 29 of the latter), the series of Kasemeyer in which lipomata were twice as common as either myomata or fibromata in causing intussusception, the 104 cases of lipomata reviewed by Derocque as compared with 45 cases of fibromata reviewed by Clifton and Landry, and 58 intestinal myomata reported by Hake, lead to a different conclusion. Although there are no conclusive data on the

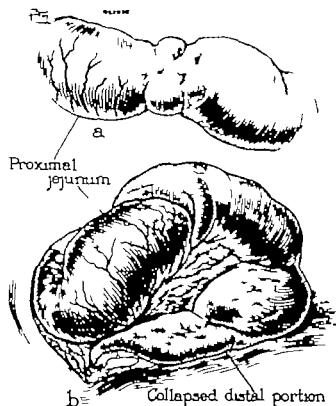


Fig. 1. a Intussusception of jejunum b jejunum and tumor after reduction of intussusception

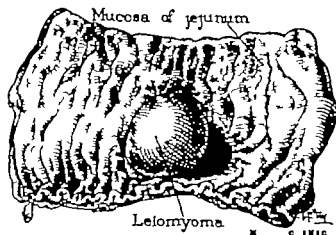


Fig. 2. Leiomyoma which extended into the lumen of the jejunum.



Fig. 3 Section of leiomyoma stained by van Gieson contrast method to show smooth muscle.

subject we believe that lipomata occur with about twice the frequency of either myomata or fibromata. If myxomata are included with fibromata to which they are generically similar the incidence of fibromata and myomata is about the same, although the question is still in dispute (12). It must be remembered that in the various cases reported the tumors were examined by many pathologists using various staining methods, and if it were possible for all the specimens to be examined by the same person with uniform stains, the resulting ratios might be entirely different, or might substantiate the term "fibroid" as used by Bland Sutton, or the more accurate term "leiomyoma" as used by Rieniets for the small benign tumors of the stomach.

REPORT OF TWO CASES

CASE 1. A man, aged 57 years, came to the clinic December 3, 1931. He complained chiefly of a painful mass in the abdomen. The trouble had begun in April, 1931, as an occasional knife-like pain before stool. The attacks became more frequent and for the previous two and a half months had occurred 10 to 15 minutes after eating and were accompanied by the formation of a mass. The mass in the abdomen would shift from left to right and disappear when massaged. There had been neither nausea nor indigestion, but much eructation and hiccoughing.

General examination showed the abdomen to be tender at the left of the umbilicus; an indefinite mass was palpable. Operation was advised for a tumor of the small intestine.

December 10, 1931. Intussusception of the middle of the jejunum was reduced (Fig. 1) 12 centimeters of the intestine was resected and an end-to-end anastomosis was made for the removal of a tumor of the small bowel (Fig. 2). Enterostomy was made above the anastomosis. The pathologist found a leiomyoma 3.5 centimeters in diameter showing myxomatous degeneration (Fig. 3). The patient's convalescence was uneventful and he was dismissed December 3.

CASE 2. A man, aged 57 years, came to the clinic November 30, 1931, with the complaint of a sense of fullness

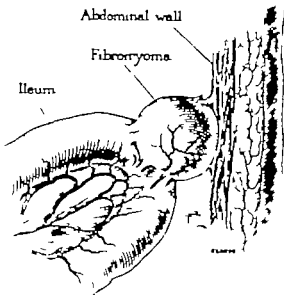


Fig. 4. Leiomyoma of jejunum attached to scar on abdominal wall.

in an operative scar. In December, 1930, he had been operated on and stated that he thought a ruptured appendix had been removed and the abdomen drained. The operation was followed by a stormy convalescence which confined him to bed for 7 weeks. Afterward he recuperated steadily but had gas pains at the site of the scar and could feel a lump in the wound.

General examination was negative except for the right rectus incision. In the center of the incision was a smooth, firm mass, about 9 centimeters in diameter which was partially fixed; it was painful only when pulled outward from the abdominal wall. Excision of the mass was advised.

December 3, 1931, the scar and the mass were removed. The mass was incorporated in the musculature of the lower part of the jejunum and it was necessary to resect the muscle down to the mucosa to remove the tumor (Figs. 4 and 5). The appendix was atrophic but otherwise normal. The pathologist reported degenerating leiomyoma (Fig. 6) of the jejunum (6 by 4 by 4 cm.) attached to the abdominal wall. Convalescence was uneventful and the patient was dismissed December 7.

The etiology of intestinal fibromata (the term generally used in clinical literature for these tumors) is not known (3) and the theory of inclusion or embryonal rests (6, 14) is at present as acceptable as any other.

The position of the fibromata may be intraluminal or extraluminal, a division which Hertzau thought to be due to the tumor arising from the submucous connective tissue in the first type or from the subserosal tissue in the second type. The most thorough report on the subject is the review of 45 cases of fibroma by Clifton and Landry. In 25 of these cases the tumor was in

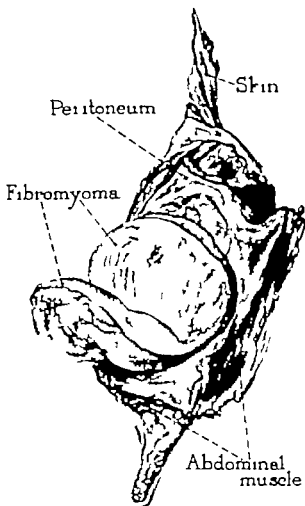


Fig. 5 Tumor and attached scar of abdominal wall.

the small intestine and in all but 2 cases was intraluminal in type. The average age of the patients affected was 39 years, most of them were between 30 and 60 years, although Willis reported the case of a fibroma in the intestine of a girl aged 8 years. The tumor occurs almost equally in the two sexes and is most common in the ileum.

The outstanding clinical characteristic of fibromata of the small intestine is that of causing intussusception. Bland Sutton reported a case of an extraluminal fibroma causing obstruction by torsion of the intestine, but intussusception was present in 23 of the 25 cases of fibroma of the small intestine reviewed by Clifton and Landry. That benign tumors frequently cause intussusception in adults had been previously pointed out by Eliot and Corcoran, who found them to be the cause of intussusception in 60 of a collection of 300 cases. This is in contrast to malignant lesions in the small bowel. Although malignant lesions in the small bowel are by far more common



Fig. 6 Section of tumor stained by van Gieson contrast method to show smooth muscle.

(10) the incidence of intussusception is low. Judd in reporting 24 cases of carcinoma of the small intestine observed in The Mayo Clinic prior to 1919 noted only 2 cases in which intussusception was present, and Rankin and C. W. Mayo in a report of 31 cases from The Mayo Clinic from 1919 to 1929 failed to mention intussusception as a complication. The reasons for this lack of invagination are probably the frequency of the napkin ring or circular type of carcinoma and the comparative rapidity with which adhesions are caused in malignant cases.

The means whereby the intussusception is caused has been considered by various authors, and Jason and Filiberbaum summarized the hypothesis into the following: (1) the weight of the tumor dragging the intestine; (2) violent peristalsis due to a reaction to a foreign body; (3) spasm of the intestine at the site of the tumor; (4) perverted action of muscles; and (5) paralysis of the bowel. It is probable that several of these factors enter into all cases of intussusception.

The intussusception caused by a fibroma may be acute, recurrent or chronic, and the clinical picture will vary with the type as well as the situation of the obstructing lesion. Since the majority of these lesions are situated below the middle of the jejunum, the fulminating symptoms of obstruction high in the intestine are usually absent. In the acute cases a sudden onset of cramp-like pain and a mass in the abdomen are the best guides to the diagnosis. In Eliot and Corcoran's 60 cases of intussusception caused by benign tumor a mass was palpable in 22. In the recurrent type a shifting abdominal tumor with the attacks will indicate the trouble. The chronic type, in which there is sufficient lumen to allow

the passage of some material may offer the most difficult diagnosis and be indistinguishable from chronic constipation or partial obstruction from any cause. Nausea and vomiting are variable symptoms. Melena may result from an ulceration of the mucosa covering the tumor but is not as common as in cases of intussusception among children.

Examination of the intestinal tract by the roentgen-rays must be done with great caution. In the acute type of intussusception it is manifestly contra indicated, and in the recurrent and chronic types an acute attack with complete obstruction may be precipitated.

With the diagnosis made surgical exploration is the treatment indicated. Although it is possible that benign tumors and whole intussusceptum may pass by way of the anus, delay in operating cannot be condoned. The operative procedure must be adopted to the case and to the surgeon's skill. Resection and an anastomosis is usually done. The operative mortality reported in the series of 25 cases reviewed by James and Sappington, and the 45 cases reviewed by Clifton and Landry was slightly more than 27 per cent.

SUMMARY

Two cases of fibromata of the jejunum are reported. The patients were both aged 57 years. The first case was a fibromyoma of the intraluminal type, which caused recurrent attacks of intussusception. The second case was a fibroma of the extraluminal type and was attached to an abdominal scar and caused slight symptoms on pressure.

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THE ADVANTAGES OF AN EXTREME TRENDLENBURG POSITION IN OPERATIONS OF THE UPPER RESPIRATORY TRACT

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THE reason for the occurrence of pulmonary abscess and pneumonia following operative procedures has occasioned considerable discussion. Clinical evidence and experimental evidence are often conflicting especially the statistics of various operators who have written upon this subject. Some experimenters have reported failures to produce pulmonary abscess by the introduction of infected material into the bronchi unless there has been some injury to the mucous membrane lining the bronchi while others have reported a certain percentage of success. It is possible that the failure of animal experiments along this line may be due in part to the natural immunity of dogs to the infectious micro-organisms to which a human being is vulnerable.

A few writers have reported a large series of tonsillectomies with but few or no pulmonary abscesses or pneumonia following. The majority of clinicians, however, acknowledge varying percentages. It is claimed by some that pulmonary abscess following tonsillectomy is embolic in origin and does not come from aspiration. It is notable however that the greater percentage of pulmonary abscesses occur following operations in the upper respiratory tract and oral cavity and the majority have followed tonsillectomies. Lung abscess does not often follow drainage appendicitis and pelvic operations, or others remotely situ-

ated of a similar type from which the transference of septic emboli to the lungs should be expected.

The first reported cases were by Richardson about 18 years ago and up to that time the attention of the profession had not been called to this possibility. Prior to that such complications were attributed to other sources.

The frequency of the occurrence of postoperative lung abscess varies with different observers. Moore reports one in about every 2,500 tonsillectomies. Lord in reviewing 227 cases of lung abscess recorded that 60 were postoperative and of this number 82 per cent followed operations about the upper respiratory tract.

Various observers have made a series of bronchoscopic observations following tonsillectomies and have found aspirated blood in the trachea in a rather large percentage of cases. It is recognized that the respiratory tract rid itself of foreign particles with considerable facility if normal reflexes are undisturbed and if the mucosa is unbroken infection is less frequent. However aspiration of any infectious germ or pathological tissue is a factor of risk especially if the mucosa is broken or irritated by inhalation anesthesia.

It is the purpose of this paper to call attention to a technique we have always used which minimizes and probably in most cases eliminates any aspiration of blood secretions, or infective mate-

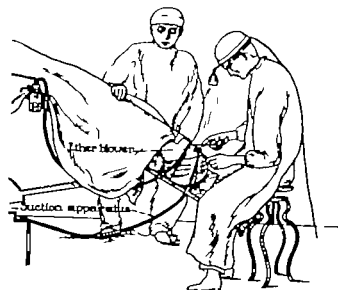


Fig. 1. Application of apparatus.

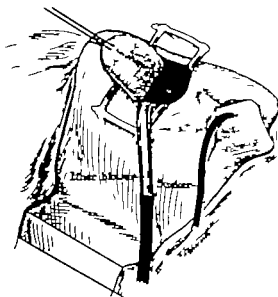


Fig. 2. Tongue depressor and hand controlled mouth sucker are used except in cleft palate cases.

the passage of some material may offer the most difficult diagnosis and be indistinguishable from chronic constipation or partial obstruction from any cause. Nausea and vomiting are variable symptoms. Melena may result from an ulceration of the mucosa covering the tumor but is not as common as in cases of intussusception among children.

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JEJUNAL ULCER

AN ANALYSIS OF THIRTY SIX CASES AND STUDY OF THE LITERATURE¹

EDWARD B. BENEDICT M.D., Boston

Jejunal ulcer following gastro-enterostomy is so serious a complication and its incidence is so much in dispute that a careful review of cases proved by operation or demonstrated by X ray examination should be of interest. Balfour's latest reports indicate an incidence of only 3.26 per cent, which contrasts sharply with figures of 20-34 per cent reported by Berg, Lewisohn, Strauss and others. Prominent German and Austrian surgeons have for some time been advocating radical resections for peptic ulcer because of the high incidence of jejunal ulcer. Whether there is a racial difference in the size and type of peptic ulcer encountered in different countries is an interesting question. Walters and Snell gave their attention to this question last year when traveling in Europe and concluded that owing perhaps to coarse irritating dietary habits the type of multiple ulcers with gastritis met with in the people of central Europe seems amenable only to radical surgery, whereas the usual type of single ulcer found in France, England and America responds well in 90 per cent of the cases to less radical surgical procedures. That diet alone is probably of great importance in the development of gastroduodenal ulcer is indicated by Bergsma's recent observations on the black people of Abyssinia in whom the incidence of peptic ulcer is very high and whose chief article of diet from the age of 2 years is sour bread with a sauce of 50 per cent cayenne pepper!

INCIDENCE

The number of cases of duodenal ulcer for which posterior gastro-enterostomy has been done at the Massachusetts General Hospital and in which jejunal ulcer has subsequently been proved at operation in this hospital is only 7. As there have been 732 gastro-enterostomies for duodenal ulcer in this hospital the incidence of proved jejunal ulcer is practically 1 per cent. It has not been possible, however, to trace all cases. There have been 14 cases of jejunal ulcer proved by operation in this hospital in which the gastro-enterostomy was done at another hospital. To compensate for our untraced cases these 14 may be added, making 21 cases of proved jejunal ulcer. If we still use 732 gastro-enterostomies as a basis, the incidence of jejunal ulcer is 2.9 per cent. If 15

more cases of probable jejunal ulcer, diagnosed clinically and by X ray, are added the incidence of jejunal ulcer is nearly 5 per cent. The latter figure, however, is almost certainly too high for it includes unproved cases as well as cases in which the gastro-enterostomy was performed at another hospital. Taking the incidence of 2.9 per cent as most likely to be correct, we find it in close agreement with Balfour's latest figure of 3.26 per cent.

AGE

The age incidence of course depends considerably on the age at the time of the gastro-enterostomy. The youngest patient in this series (Case 1) was only 18 years of age at the time of gastro-enterostomy and only 21 at the time of recurrence of ulcer symptoms. At the age of 24 years a secondary operation was done and jejunal ulcer demonstrated. The oldest patient (Case 3) was 56 years old at the time of gastro-enterostomy, 5 years later this patient required repair of a gastrotrojuncocolic fistula. In general jejunal ulcer occurs during the middle period of life, the average age at the time of the secondary operation being 43 in this series. According to Smyth gastro-jejunal ulcer has been reported in a baby 2 years old after gastro-enterostomy for pyloric stenosis and also in a patient of 81 years after gastro-enterostomy for ulcer.

SEX

Jejunal ulcer like gastroduodenal ulcer, is largely a disease of men, only one woman being found in this series. Balfour reported 270 cases with only 22 women. That average gastric acidity is higher in the normal male than in the normal female has been shown by many observers and confirmed recently by Lerman, Pierce, and Brogan. This may be of significance in the high proportion of males having gastroduodenal and jejunal ulcer.

ETIOLOGY

Primary jejunal ulcer. Jejunal ulcer is for all practical purposes an artificial disease secondary to gastro-enterostomy. Richardson, however, was able to collect 10 cases of primary jejunal ulcer from a complete review of the literature, adding to the report 2 cases which occurred in the Massachusetts General Hospital. The etiology

of these rare primary jejunal ulcers is not known.

Gastrojejunal ulcer. A distinction should be made in postoperative ulcer between *gastrojejunal* ulcer which occurs exactly at the line of suture and *jejunal* ulcer which occurs a few centimeters away from the stoma, usually in the efferent loop. In the former it is the generally accepted belief that the use of non-absorbable suture material plays a major rôle in the etiology. This point has been well established experimentally by Groenerud, who performed gastro-enterostomy on several hundred dogs, finding secondary gastro-jejunal ulcer common when silk sutures were used but uncommon when absorbable sutures were used. Clinical experience substantiates these observations.

Secondary jejunal ulcer. The etiology of postoperative jejunal ulcer occurring a few centimeters from the anastomosis, is not so clear. A number of theories will be discussed.

Hyperacidity theory. Hyperacidity is probably the most important factor. Acid gastric juice impinging constantly on jejunal mucosa unaccustomed to receive it might reasonably be expected to cause trauma and to predispose to ulcer formation. In support of this theory are a number of clinical and experimental observations.

1. Jejunal ulcer is almost unknown after gastro-enterostomy for carcinoma of the stomach. Key however did report a case of jejunal ulcer after partial gastrectomy and anterior gastro-enterostomy for carcinoma. The gastric acidity was not studied in this case and may have been high after resection. Judd also mentioned a case which occurred at the Mayo Clinic after resection for cancer. No cases have been found in the literature occurring after simple anterior or posterior gastro-enterostomy for carcinoma. This would seem to be of significance in view of the usual anacidity or hypoauidity in gastric cancer. It might be argued that such patients do not live long enough to develop jejunal ulcer but they may survive 6 months or more after gastro-enterostomy in which length of time it is possible to develop an anastomotic ulcer.

2. Jejunal ulcer is much more common after anterior gastro-enterostomy or after the Roux gastro-enterostomy en Y than after posterior gastro-enterostomy (Montgomery, Gossett, Moy nihan, Paterson). The explanation seems to be that in gastro-enterostomy by the anterior method a long jejunal loop is used thus making the stoma a long way from the neutralizing effect of the alkaline duodenal contents. Furthermore, when an entero-enterostomy is also performed as is usu-

ally the case in anterior gastro-enterostomy the alkaline juices are likely never to reach the site of anastomosis at all. Likewise in the gastro-enterostomy en Y there is very little possibility of neutralization in the jejunum near the stoma. In spite of the relative frequency of secondary jejunal ulceration after anterior gastro-enterostomy for ulcer we have observed above that it is never seen after gastro-enterostomy for carcinoma, where the anterior operation is so common.

3. Jejunal ulcer is very much more common after gastro-enterostomy for duodenal ulcer than after gastro-enterostomy for gastric ulcer. Bal four in a study of 139 cases of jejunal ulcer occurring in cases in which the original gastro-enterostomy had been done at the Mayo Clinic, found 130 followed gastro-enterostomy for duodenal ulcer and only 9 followed gastro-enterostomy for gastric ulcer. In 381 cases of gastric ulcer operated on at the Massachusetts General Hospital since 1908, jejunal ulcer has not been observed to follow gastro-enterostomy in any case. Many more cases of duodenal ulcer show hyperacidity than do cases of gastric ulcer as has been shown by Kalk at von Bergman's clinic and Hurst and Stewart in London hospitals. Quoting from Lindau and Wulff Hurst and Stewart's figures show hyperacidity in 61 per cent of cases of duodenal ulcer and in 32 per cent of cases of gastric ulcer and Kalk's figures indicate hyperacidity in 75 per cent of cases of duodenal ulcer and in only 29 per cent of cases of gastric ulcer.

4. Morton and Graham have reported the case of a patient who after cholecystectomy and drainage of the common bile duct died suddenly 24 days after operation of hemorrhage from a duodenal ulcer which had apparently formed as a result of stones impacted in both the common bile duct and the pancreatic duct with complete blockage of these secretions. As no ulcer was found at the time of the cholecystectomy the conclusion is that it developed as a result of the failure of the alkaline secretions to enter the duodenum and neutralize the gastric juice. Thus the neutralization of gastric acidity is shown to be of importance for the protection of duodenal as well as jejunal mucosa. Holzwieser's case cited by Hauser is very similar eight erosions and ulcers of the jejunum occurring in a woman of 58 years with an obstructed ampulla.

5. Jejunal ulcer is rare in women, there being only one case in this series and relatively few in the literature. Sherren has noted this and the lower gastric acidity in women believing that this indicated the importance of hyperacidity in jejunal ulcer formation.

6 Experimentally in dogs, Mann and Williamson and later Morton have anastomosed the jejunum directly with the stomach, shunting the duodenal secretions into the ileum—so called surgical duodenal drainage. When this is done a typical peptic ulcer invariably develops in the jejunum close to the pylorus where the acid gastric juice impinges upon it. When the alkaline duodenal secretions are restored to this area the ulcer heals.

7 Ivy and Fauley have shown by performing surgical duodenal drainage in dogs and leaving an inch or so of duodenum attached to the pyloric end of the stomach that ulcer always develops in the jejunal mucosa and not in the duodenal mucosa, although the latter is subjected to the same force of impinging gastric juice. This seems to indicate that, under the same conditions, jejunal mucosa itself is more susceptible to ulceration from the action of gastric juice than is duodenal mucosa.

8 Elman and Hartmann by continuous external drainage of the pancreatic secretion in dogs have shown that duodenal ulcers develop constantly under such conditions, indicating the importance of the pancreatic secretion in neutralizing the acidity of the gastric juice and protecting the duodenal mucosa.

9 Further evidence of the importance of the acidity of gastric juice in ulcer formation is brought forth by Lindau and Wulfs, who call attention to ulcer of Meckel's diverticulum in which gastric mucosa with fundus glands can be demonstrated, and in which the presence of free hydrochloric acid has proved to be a regular finding. These authors point out that peptic ulcer is found in the esophagus cardia, area of pyloric glands, duodenum jejunum (postoperatively) and in Meckel's diverticulum, and that in all these areas there is activity of hydrochloric acid, which they regard as of very great importance in etiology.

10. Rivers and Wilbur have recently called attention to gastro-ileal ulcers following the unfortunate surgical error of gastro-ileostomy when gastrojejunostomy was intended. They conclude that "clinical evidence is suggestive that the potentiality for the development of peptic lesions arises whenever and wherever any segment of intestinal mucosa is exposed to the eroding action of the gastric chyme."

11 Morton found by passing duodenal tubes in 33 patients with peptic ulcer that all showed free hydrochloric acid in the duodenum, whereas 13 persons without peptic ulcer did not show free hydrochloric acid in the duodenum.

12 Goldberg has recently called attention to experimental peptic ulcer formation in dogs in which a section of ileum has been used to form a permanent external fistula from a gastric pouch. The pure gastric juice acting on the mucosa of the ileum is apparently the important factor in ulcer formation in these animals.

Theory of infectious origin Another factor which may be of significance in jejunal ulcer formation is infection. It is impossible to evaluate its importance, but it is reasonable to state that no medical treatment of peptic ulcer is complete without attention to foci of infection such as teeth, tonsils, appendix, gall bladder, prostate, and cervix to which Moynihan adds that in performing gastro-enterostomy a diseased appendix or gall bladder should be removed. In this connection I will quote Wilkie's views on peptic ulcer.

The prevalence of dental infection is to my mind the most important single factor in determining the frequency of peptic ulcer. In many of these cases we recover from the pyorrheal pockets the same streptococcus as we find in the ulcer. The combination of an ulcer in the stomach or duodenum or both with infection in both gall bladder and appendix is quite common. All these lesions must be dealt with if complete and lasting relief is to be obtained." In this connection Wilkie cites a case of jejunal ulcer with associated inflammation of the appendix and gall bladder. *Streptococcus viridans* was grown in pure culture from regional lymph glands from all three sites and when this streptococcus was injected into rabbits both duodenal ulcer and cholecystitis were produced!

Other factors in the etiology of gastrojejunal and jejunal ulcer are related (1) to *general medical management*, such as diet, smoking use of alcohol, etc., or (2) to *faulty surgical technique*, such as the use of non absorbable sutures too small a stoma, badly placed stoma, or (3) to *improper selection of cases*. The importance of proper medical care after gastro-enterostomy is generally recognized, though it is difficult to know for how long a period a strict diet should be followed. Many patients after a few months on a careful regimen find that they can return to normal dietary habits without ill effect. Others have to be careful to avoid highly acid fruits, meat and fried or rich foods, and of course some have to be still more careful to live on a very bland diet. Excessive use of tobacco or alcohol should be avoided though some patients tolerate them. Faulty surgical technique seems to be an obvious factor in etiology. Gastrojejunal ulcer with small pieces of silk or linen suture material hanging from its center has been

TABLE I.—SUMMARY OF PROVED JEJUNAL ULCER CASES
Jejunal Ulcer Proved at Operation

Case No. Identification	Sex Age Date of P.O.E.	Date of P.O.E. Duration of med. treat- ment	Obstruction by X-ray	Total acidity**	Suture material used in P.O.E.	Type of operation	Append- ectomy	Symptom free after P.O.E.
Posterior Gastro-Enterostomy Done at Massachusetts General Hospital								
E.H.T. 574	M 3	97 14 years, doubtful	None	83 cm.	Linen, chronic catgut	P.O.E. with infolding	Yes	3 yrs. 9 mos.
T.S. 99473	M 3	938 6 mo.	None	72 cm.	Catgut	P.O.E. for perforating duodenal ulcer, gastro- enterostomy for mal- functioning P.O.E.	No	Between 3 and 4 mos.
T.M.D. 30973	M 46	91 None	Not stated	83 c.cm.	Catgut	P.O.E. for? carcinoma of perforator to antiperist. obstruction	No	4 yrs.
D.J.S. 53293	M 50	9 5 mos.	None	64 c.cm.	Deep, chronic catgut	P.O.E. for perforation	No	3 yrs.
M.E. 10095	M 4	95 None	None	99 cm.	Linen, chronic catgut	P.O.E. for perforation	No	3 yrs.
O.L.K. 35	M 34	1918 doubtful	Yes, marked at the only pre-operative examination	70 cm.	Linen, catgut	P.O.E. ulcer not in- folded	1909	37
W.R.E. 25 290	M 58	916 None	93 in 6 hr. residue. 916 maximum 6 hr. residue	120 cm.		Excision of ulcer P.O.E.	No	9 yrs.
Posterior Gastro-Enterostomy Done at Various Hospitals								
A.E.S. 3 17715	F 44	3 None	Yes	Not stated	Chronic cat- gut, peris- ter layer silk	P.O.E.	1905	6 yrs.
L.J. 1 5676	M 29	93 3 yrs.	Not stated	Not stated	Not stated	P.O.E.	No	18 yrs.
W.H.H. 196433	M 3	913 Not stated	Not stated	Not stated	Not stated	P.O.E.	1901	14 yrs.
L.W.V. 300334	M 3	924 None	Not stated	Not stated	Not stated	1914 P.O.E., 1927 pyloroplasty	No	3 yrs. 10 mos.
Z.J.C. 166967	M 44	927 5 yrs.	No	70 c.cm.	Not stated	Posterior Polya	No	10 days
W.D.S. 303715	M 4	927 17 doubtful	Not stated	Not stated	Not stated	P.O.E.	No	unk.
A.T. 1064354	M 43	9 Not stated	Not stated	Not stated	Not stated	P.O.E. short loop, Mayo method	X	3 yrs.
W.H.E. 136400	M 39	919 None	Not stated	Not stated	Not stated	P.O.E. no ulcer found	1907	Not stated

P.O.E. Posterior gastro-enterostomy.

*Cases 1, 2, 3, 7 and 8 have been previously reported by Davis, Lincoln—Berg. Gynec. & Obst. 1927. By 1921.

**The total acidity is given in cm. of normal sodium hydroxide (1 cc. after last meal). In all cases prior to 1926, bismuth was not used.

In practically all cases for the past 5 or 6 years, bismuth has been used.

***Reported by courtesy of Dr. A. W. Allen.

TABLE I—SUMMARY OF PROVED JEJUNAL ULCER CASES
Jejunal Ulcer Proved at Operation

Recent symptoms	X-ray evidence of jejunal ulcer	Total acidity	Date of operation for jejunal ulcer	Type of operation for jejunal ulcer	Result
Posterior Gastro-Enterostomy Done at Massachusetts General Hospital					
Pain in epigastrium, melena	Spurred con- tracted stomach	Not stated	(1) 2-9-11 (2) 11-6-13	(1) Excision, (2) P.G.E. anastomosis	(1) Not relieved, (2) Several hemorrhages into duodenal ulcer. Symptom-free past 8 yrs. on milk diet only
Hematemesis, melena, pain to left of umbilicus	Yes	Not stated	1919	P.G.E. and entero-enterostomy anastomosis	Fully well on medical treatment past yrs. Recs 2-9-13
Melena; diarrhea after wash pain in epigastrium, diffuse, reaching to umbilicus	Yes gastro-jejunal colic	1 ccm.	1921	Closure of ga. trojejunocolic fistula and G.E. with excision of jejunal ulcer	Died 13 days after operation—peritonitis
Hematemesis, melena, pain in mid-epigastrium occasionally radiating to left inguinal region	Yes	1 ccm.	1927	Subtotal gastrectomy. Shamaker method	Doubtful improvement. Died 8 mos. after operation, after amputation both legs for arteriosclerotic gangrene also had tertiary syphilis and tabes
Hematemesis, melena, epigastric pain	Yes	Not stated	1928	Excision of gastroduodenal ulcer; resection of stomach. Pólya anastomosis	Feeling very well and eating almost everything. Recs 3-1-33
Artificial diarrhea, melena	Yes, gastro-jejunal colic	60 ccm.	1932	Updocking of P.G.E., closure of fistula	Gaining weight and doing well 3-12-33. Needs further operation 4-3
Anorexia, melena, vomiting; dull pain under right costal margin	Yes	87 ccm.	1937	Separation of G.E., pyloroplasty Pólya method, 2-3 of stomach removed	Patient writes that he is cured. 11/2 yrs. relieved by hot milk, anorexia, vomiting, and gas 2-29-41
Posterior Gastro-Enterostomy Done at Various Hospitals					
Epigastric pain as before P.G.E., most recent abdominal pain at left, steady hematemesis; melena	Yes	7 ccm.	1931	Gastric resection posterior Pólya anastomosis	Relieved, gaining weight 7-14-31
Pain at umbilicus, radiating down toward pubic umbilicus	Yes	0-0-3 O 10-4-31 38 ccm.	1933	P.G.E. anastomosis. Halsey Althaus pyloroplasty	Feeling well 4 mos. after operation. Vomiting, hematemesis. Gastroenterostomy Feb. 1935
Vomiting; pain in l.u.g., over most of left abdomen; "jump" in l.u.g.; diarrhea, loss of weight and weakness	Yes, gastro-jejunal colic	50 ccm.	1937	Subtotal resection of stomach, anterior Pólya resection of transverse colon and end-to-end anastomosis	Died 1938, cause unknown
Pain similar to that before P.G.E., starting in epigastrium, spreading to loins and chest; hematemesis; melena	No	21 ccm.	1939	Resection of stomach gastro-jejunoenterostomy (Pólya)	Feeling well and eating almost everything. Recs 3-1-41
Lower abdominal pain; hematemesis; melena	No X-ray taken	Not stated	{ 7-23-40 { 7-27-40	{ Resection of jejunum. { Anterior Pólya resection and entero-enterostomy	Symptom-free on 5-meal bland diet. Recs. 3-17-41
Pain in l.u.g. radiating to lower quadrants and back, weakness and lower epigastrium; melena	Yes	1-4-40 18 ccm. 2-21-40 68 ccm.	1940	Resection of jejunum with ulcer anastomosis of jejunum, P.G.E.	Died 6 days after operation of general peritonitis and hemorrhage into stomach
Hematemesis, melena, epigastric pain, gas and burning after meals	Yes	23-45-14 61 ccm. 11-18-18 38 ccm.	1943	Excision of gastroduodenal ulcer	Relates of symptoms 1 mos. postoperative, weakness and anorexia. 11 yrs. later? malignancy of liver
Diarrhea and vomiting; no pain	Gastrocolic fistula	90 ccm.	1945	Repair of colic fistula; closure of jejunal stomach; resection of pyloric third of stomach. Pólya anastomosis of stomach and jejunum; colostomy	Very satisfactory Recs 3-13-45

P.G.E. Posterior gastro-enterostomy

Cases 1, 5, 15, 17 and 20 have been previously reported by Davis, Lincoln—Burg, Gynec. & Obst., 1937, p. 304.

*The total acidity is given in c.c.m. of 0.2 normal sodium hydroxide 1 hour after test meal. In all cases prior to 1930, histamine was not used. In practically all cases for the past 5 or 6 years, histamine has been used.

†Reported by courtesy of Dr. A. W. Allen.

TABLE 1—SUMMARY OF PROVED JEJUNAL ULCER CASES—Continued
Jejunal Ulcer Proved at Operation

Case No. Description	Sex Age at time of P. O. E.	Date of P. O. E. Duration of most recent attack	Obstructive by X-ray	Total acidity*	Swiers material used at P. O. E.	Type of operation	Acid- ity post- op.	Bygones after P. O. E. yes no
Posterior Gastro-Enterostomy Done at Various Hospitals								
1 A	M 30	None	Not stated	Not stated	Lumen	P. O. E.	X	Keen, sym- ptom-free
1 B	M 40	19 None	Not stated	Not stated	Not stated	Excision of short P. O. E.	1927	8 mos.
1 C	M 30	1910 Not stated	Yes	Not stated	Not stated	P. O. E.; gastro-entero- stomy approximately	Yes	3 yrs.
1 D	M 30	1910 Not stated	Not stated	Not stated	Not stated	O. E.	X	3 yrs.
1 E	M 30	1910 Not stated	Not stated	Not stated	Not stated	O. E. for P. O. E. of stomach	X	8 yrs. 3 mos.
1 F	M 30	1910 Not stated	Not stated	Not stated	Not stated	P. O. E.	1919	1 yrs.

*Acid-ity.

* have been previously reported by Dr. H. Lancaster—Berg, *Gastro. & Obst.* 1927, 37, 102.

* or less of normal acidity by drainage hour after test meal. In all cases prior to 1919, histamine was not used.

* the past 1 or 2 years, histamine has been used.

* 1/2 hr. after test meal.

repeatedly reported. That trouble may follow too small a stoma is also evident, though it is not always possible to say whether a small stoma has led to ulcer formation or whether an ulcer has formed in a leading to contraction of the stoma. In one of the cases in this series (Case 9) a high stoma with jejunal ulcer was found, and yet this patient had been well for 18 years after gastro-enterostomy. It seems likely that factors other than the poorly placed stoma must have been at work in this case to bring about a recurrence 18 years later. Regarding the proper selection of cases for gastro-enterostomy it is well known that the poorest results follow this operation when it is performed in cases in which the diagnosis is not positively established, or in which insufficient medical treatment has been followed.

A study of the 36 cases tabulated in this series brings out the importance of the various etiological factors mentioned. The lack of sufficient medical treatment before operation is an outstanding feature in almost every case. Of course, the three (Cases 2, 4, and 5) that perforated after

only a short period of medical treatment required immediate operation but should not have been subjected to gastro-enterostomy at that time particularly as in addition to their very short dietary regimen both showed hyperacidity and no pyloric obstruction by X-ray. In such cases simple suture of the perforation should be sufficient, with gastro-enterostomy later if indicated. Next in importance would appear to be pre-operative hyperacidity almost all the cases ranging in the upper limits of normal or definitely higher. Wilkie considers hyperacidity of such great importance in jejunal ulcer formation that in such cases he performs gastroduodenostomy rather than gastro-jejunoostomy. Secondary ulceration after gastroduodenostomy occurs very rarely if at all, the stoma being placed near the ampulla of Vater where the acid is quickly neutralized by the pancreatic juice. The postoperative gastric acidity in the presence of jejunal ulcer, appears to be a very variable quantity depending probably on the neutralization at any given moment by duodenal secretions entering through the stoma. In

TABLE I—SUMMARY OF PROVED JEJUNAL ULCER CASES—Continued
Jejunal Ulcer Proved at Operation

Recurrent symptoms	X-ray suggestive of jejunal ulcer	Total acidity	Date of operation for jejunal ulcer	Type of operation for jejunal ulcer	Result
Posterior Gastro-Enterostomy Done at Various Hospitals					
Epigastric pain nausea vomiting gas and sour eructations	No	Not stated	9 6	Separation of P.G.E. resection of jejunum linea suture found in jejunal ulcer	Died 3 week after operation with discharging wound and pulmonary complications
Epigastric pain 2-3 hr after meals, relieved by food and soda vomiting loss of weight	Yes Stoma closed	35 cm.	924	Undoing of old P.G.E. excision of jejunal ulcer	Symptoms returned 3 wks. after operation reentry 8 mos. later with operation for recurrent duodenal ulcer partial gastrectomy and P.G.E.
Pain in epigastrium radiating to whole abdomen nausea and vomiting	No report	Not stated	103	Suture of perforated ulcer of jejunum	Good postoperative convalescence 7-8-3
Pain in lower abdomen at night and 3-4 hours after meals, relieved by food and vomiting pain at umbilicus 2-5 hrs after evening meal	Yes	55 cm.	9 3	Closure of G.E., excision of gastrojejunal ulcer gastro-duodenostomy	Symptom-free 3 mos. after operation, then recurrence of epigastric pain and vomiting treated in hospital 3 days diagnosed probably recurrence of original ulcer medical treatment advised
Epigastric pain on right no definite relation to meals, relieved by soda, heat, or vomiting gas anorexia	Yes Stoma closed	30 c cm.	9 1	Closure of subacute perforation of duodenal ulcer removal of old G.E. for gastrojejunal ulcer	Feeling pretty well, but some upper abdominal pain every 2-3 weeks, relieved by soda can eat any food. Seen 1 10-32
Pain over pubes, radiating to back, later pain in upper left abdomen, non-radiating distention relieved by food; diarrhea	Gastrocolic fistula	45 c.cm	93	Excision of ulcer butt of P.G.E., suture of colon, stomach, and intestines	Discharged from hospital 6 wk., 7-7-32 No further follow-up

P.G.E. Posterior gastro-enterostomy

*Cases 5 15 7 and 20 have been previously reported by Davis, Lincoln—Surg., Gynec. & Obst., 9 7 E 1911.

†The total acidity is given in cm. of normal sodium hydroxide 1 hour after test meal. In all cases prior to 1916 histamine was not used. In practically all cases for the past 3 or 4 years, histamine has been used.

**Reported by courtesy of Dr. A. W. Allen.

any case the gastric acidity is usually lowered by gastro-enterostomy, but there seems to be no definite relationship between postoperative acidity and jejunal ulcer. The relationship of the appendix to jejunal ulcer formation is not proved but it may be significant that in most of the jejunal ulcer cases the appendix had not been removed. Eleven of the cases showed no pyloric obstruction by X ray and although we know that many gastro-enterostomies are entirely successful even in the absence of such obstruction we feel that the most successful cases are usually those with obstruction. Five cases (6 7 8 18 20) however showing obstruction by X ray examination subsequently developed jejunal ulcers. Hence it is evident that gastro-enterostomy even when performed to relieve obstruction may result in jejunal ulcer formation. Furthermore obstruction revealed by the X ray is inconclusive unless shown at repeated examinations and confirmed by the clinical picture. Unabsorbable suture material was known to have been used in this series in only 6 of the operated upon jejunal ulcer cases

(1, 5 6 8 16 20) (sometimes only for the serous layer), in 1 case (16) the linen suture was found at the operation for jejunal ulcer. It is probably a factor of importance when used for the mucosal suture. Six patients (Cases 1 2 10 12 17 32) in this series were only 25 years of age or younger at the time of their first operation. But in addition to their youth only one of these (Case 12) had had adequate medical treatment and 3 (or all those examined) showed marked hyperacidity, so that it is impossible to say that youth is a factor in the etiology of jejunal ulcer. In general however it may be said that a youthful patient frequently has not had time for prolonged medical treatment is likely to have hyperacidity and is therefore likely to be a poor subject for gastro-enterostomy. In one case in this series (Case 3) gastro-enterostomy was performed to anticipate possible obstruction from a suspected carcinoma of the pancreas. The subsequent development of jejunal ulcer in this case emphasizes the importance of not performing gastro-enterostomy except for very definite indications. Moynihan

TABLE 1A—SUMMARY OF PROBABLE JEJUNAL ULCER CASES—Continued
Jejunal Ulcer Diagnosis Clinically and by X-ray—Medical Treatment

Case No. Identified by Roentgen examination	Sex Age at time of Roentgen examination	Date of P.G.E. Duration of medical treatment	Obstruction by X-ray	Total acidify*	Serum material used in P.G.E.	Type of operation	Ap- pre- sent per cent of total body	Symp- toms before P.G.E.	Recurrent symptoms	Very marked relief of jejunal ulcer	Total acidify	Result
Posterior Gastro-Enterostomy Done at Various Hospitals												
R. J. O. 1910-11	M 30	1911 None	N	Not stated	Chronic cat- gut	P.G.E. (high vs. control)	Yes	1 yrs.	Hæmatemesis pain is (vs. pre-op) 1 hr. after soda lower than before P.G.E.	Yes	0 cm.	Medical treatment succeeded, 6-1-19
R. J. M. 1911-12	M 37	1911 None	Not stated	Not stated	None	(1) Operation for per- forating ulcer (2) P.G.E.	N	1 yr.	Hæmatemesis milder than before P.G.E.	Yes	0 cm.	Medical treatment succeeded, 1-15-10
R. J. M. 1911-12	M 35	1911 None	Not stated	Not stated	None	(1) P.G.E. (2) Pylorotomy	No	None	No below amblycus radiation factors	Yes	0 cm.	Pre-operative relief of medical treatment was good, light case. Vom 1-1-11
R. J. M. 1911-12	M 31	1911 None	Not stated	Not stated	None	(1) P.G.E. (2) Pylorotomy	N	1 yr.	Significant relief radiation factors	Yes	0 cm.	Discharged unharmed to (P.D.) 6-23-10, no fol- low-up
R. J. M. 1911-12	M 31	1911 None	Not stated	Not stated	None	(1) Pylorotomy of ulcer (2) Pylorotomy	Yes	1 yr.	Mild hæmatemesis radiation factors	Yes	0 cm.	Medical treatment succeeded, 10-8-10
R. J. M. 1911-12	M 31	1911 None	Not stated	Not stated	None	(1) Pylorotomy of ulcer (2) Pylorotomy	Yes	1 yr.	Mild hæmatemesis radiation factors	Yes	0 cm.	Medical treatment succeeded, 10-8-10

*The total acidity is given in cent. of 1 normal sodium hydroxide base after test meal. In all cases prior to 1910 treatment was not used. In practically all cases for the past 5 or 6 years

believes that nine out of ten failures after gastro-enterostomy are the result of the operation having been performed in the absence of any organic lesion justifying it

SYMPTOMS

The symptoms of jejunal ulcer are chiefly pain hæmatemesis and melena. The pain is frequently described as similar to that of the original ulcer but is usually somewhat lower down and to the left of the umbilicus not infrequently radiating to the left groin and sometimes generalized to the lower abdomen. This low abdominal pain may be evidence of adhesions to the colon though after a colonic fistula is established pain may not be a prominent symptom. The pain of jejunal ulcer is less likely to be controlled by soda or dietary measures than is the pain of gastric or duodenal ulcer. This may be due to the fact that the stomach empties so rapidly through the stoma that food remains in contact with the ulcer only a very short time. Hæmatemesis and melena are very constant symptoms, one or both being present in almost all our cases though no fatal hæmorrhage occurred. Perforation into the general peritoneal cavity may occur as happened in one case in this series (Case 18) after posterior gastro-enterostomy and entero-enterostomy of much more common occurrence is perforation into the colon which occurred five times in this series or an incidence of 13.9 per cent.

DIAGNOSIS

The diagnosis depends largely on the history of gastro-enterostomy with subsequent symptoms as outlined and the X-ray findings. Camp has stated recently that in the last two years a positive roentgenologic diagnosis of gastrojejunal ulcer has been confirmed by the surgeon in 90 per cent of cases, as compared with 74 per cent ten years ago. He bases the X-ray diagnosis on (1) the presence of an ulcer niche (which he believes can be seen in about 60 per cent of cases) (2) persistent deformity of the stomach stoma or jejunum (3) the presence of a gastrojejuno-colic fistula and (4) closure of the stoma. Camp has observed jejunal ulcer as far as 15 centimeters from the anastomosis. Of 19 cases of proved gastrojejunal or jejunal ulcers in the Massachusetts General Hospital in which an X-ray examination was made the X-ray picture was suggestive in 17 cases, or 89.5 per cent. Of the 2 cases missed by the roentgenologist one (Case 16) was in 1916 when roentgen diagnosis was less accurate than it is now and the other (Case 11) was obscured by a pylorotomy. It thus seems evident that considerable reliance may be placed on an experienced

roentgenologist in the diagnosis of gastrojejunal or jejunal ulcer

COURAZ

The course of the disease is chronic with relapses and remissions. Patients may be carried along comfortably for long periods of time on careful medical management but it is doubtful if they are ever permanently cured. There are almost always periods when rest in bed is essential because of pain or hemorrhage. A study of the results of the 15 cases treated medically in this hospital indicates that some are doing fairly well on a careful medical regimen but that very few are symptom free. All have had severe enough symptoms to necessitate hospitalization and in several operation has been advised but not performed. Perforation into the colon is a serious and not infrequent complication. A gastro-jejuno-colic fistula had occurred in 5 (Cases 3, 6, 10, 15, 1) of the 15 cases in the Massachusetts General Hospital which came to operation, or an incidence of 33 per cent in the operated cases. Adding the cases of probable jejunal ulcer treated medically the incidence of gastro-jejuno-colic fistula is 50 per cent in this hospital. This figure is somewhat higher than that found in the literature the Mayo Clinic figure being 11.36 per cent. The diagnosis of such a fistula is usually easy, for in addition to the history of gastro-enterostomy and probably of recurrent ulcer there is likely to be loss of weight and diarrhea with grossly undigested food in the stools, and the X-ray examination is almost sure to show filling of the stomach by barium enema.

TREATMENT

With the course and complications of this artificial disease thus outlined it would seem reasonable that when the diagnosis is definitely established surgery should be the treatment of choice. Each case however presents an individual problem, and in general, medical treatment should be given a fair trial and may be reasonably successful in some cases for varying periods of time. Subjective symptoms, economic disability, danger of hemorrhage or perforation are very strong arguments in favor of surgery. The disease is an artificial one produced by surgical interference and presenting very definite pathology. If a competent surgeon is available why should such a disease be allowed to continue uncured? Balfour says, "The treatment of gastrojejunal ulcer is surgical. Experience emphatically teaches that when the symptoms are those of recurring ulceration, when the roentgenogram is positive, and when relief of symptoms cannot be promptly attained and maintained by medical treatment,

early operation is the safest and most satisfactory method of management.

The surgical treatment of jejunal ulcer. Plastic operations at the stoma have been generally abandoned as ineffective. Under this heading is included simple excision of the ulcer with or without enlargement of the stoma, a change in location of the stoma, or the substitution of an anterior for a posterior anastomosis. All the factors which pre-disposed to the formation of the original jejunal ulcer are still present and such procedures usually result in the development of a new ulcer at the stoma or in the jejunum. Three of our cases (1, 13, 14) fall into this group and in none were the results satisfactory as one required further operation 8 months later, one died 6 days after operation of peritonitis and hemorrhage and the other suffered a recurrence of symptoms 10 months after operation.

Resection of the stomach is of course a more formidable procedure but, if sufficient stomach is removed, is followed by good results in many cases. The stoma must be included in the resected portion and also a fairly large section of the stomach otherwise we have left a big stomach with the pylorus excluded as in the von Eichenberg operation which is known to be followed by a high percentage of jejunal ulcers (C. H. Mayo, Leriche, Fohl, Montgomery, Wright, Laher and Jordan, de Takats and Mann von Haberer). A similar anatomical arrangement exists after pylorotomy. In three pylorotomies in this series (Cases 11, 27, 34) jejunal ulcer has developed. However resection of a large portion of the stomach is not by any means a sure preventive of jejunal ulcer for jejunal ulcer following partial gastrectomy has occurred in 2 cases in this series (12 and 25) and has been reported by Balfour, Starlinger, von Haberer, Gosset, Leriche, Strauss, and others. Resection was done in 8 of our 17 cases operated on for jejunal ulcer with good results in 5 (Cases 5, 8, 11, 12, 15), poor results in one (Case 7) and doubtful or unknown results in 2 (Cases 4 and 10). It is possible that the failure in Case 7 can be attributed to the removal of insufficient stomach. With no mortality in these 8 cases and 5 good results, subtotal gastric resection must be seriously considered in the treatment of jejunal ulcer. It is, however, a serious operation and, should it fail, further operative procedures are practically out of the question.

Fortunately there are other procedures open to us in the surgical treatment of jejunal ulcer such as undoing the anastomosis with or without some form of pyloroplasty or gastroduodenostomy.

Jejunal ulcer is clearly the result of the original operative procedure. Therefore what could be more logical than the undoing of that procedure? The objection is at once raised that if this alone is done there may be further trouble from the original duodenal ulcer. It has already been pointed out, however, that many of these cases never had adequate medical treatment in the first place and it is not at all unlikely that in such cases medical treatment after undoing the gastro-enterostomy may control the situation. Cases 1 and 2 are examples of simply undoing the anastomosis and returning the gastro-intestinal tract to its normal state. Both of these patients are getting on fairly well now on medical treatment one of them however being limited to a diet of almost nothing but milk. If however medical treatment has been given a thorough trial before the operation and there has been definite evidence of pyloric obstruction it is well in addition to undoing the anastomosis and excising the ulcer to do some type of gastroduodenostomy or pyloroplasty. There is very good authority for such procedures. Wilkie and also Cannon have stressed the fact that some form of anastomosis between the stomach and duodenum is more physiological than gastrojejunostomy. If stricture or ulceration near the pylorus persist, Richardson has suggested that resection of the anastomosis followed by gastroduodenostomy would seem to be the ideal procedure. In discussing indications for gastroduodenostomy Balfour has included failure of posterior gastro-enterostomy due to jejunal ulcer where he says the gastro-enterostomy should be undone and gastroduodenostomy performed. Judd has also subscribed to undoing the gastroenterostomy excising the jejunal ulcer and performing a plastic operation on the pylorus if it seems best. Gosset believes closure of the gastro-enterostomy alone is inadequate and should be combined with a plastic operation on the duodenum according to Judd's method which Gosset considers the best. Von Haberer according to Best, considers the Billroth No. I the operation of choice because it is the most physiologic anatomic. In a paper on jejunal ulcer Terry concludes that, in view of the very few reported cases of ulcer of the duodenum following pyloroplasty or gastroduodenostomy it would seem wise to employ these operations in suitable cases. W. J. Mayo discussing Terry's paper said they treated gastrojejunal ulcer by cutting off the gastrojejunostomy and doing a Finney pyloroplasty. Wright has likewise concluded that when secondary ulcers have formed it is best to cut off the gastro-

enterostomy and restore the natural channel if necessary by a plastic operation. Under such circumstances he mentions the usefulness of gastroduodenostomy and the Finney operation. In discussing 3 cases of jejunal ulcer following partial gastrectomy (reported by Down) Balfour sums up the present trend toward more physiological operative procedures on the stomach as follows:

The surgical treatment of jejunal ulcer is not difficult if the operation is carried out as soon as the diagnosis is made. Since we have seen a number of cases in which jejunal ulcers have recurred after repeated gastric resections it seemed reasonable to reunite the stomach to the duodenum rather than to continue with resections similar to those done previously. I look on the procedure as having the great advantage of giving an opportunity for a normal alkali-acid balance to be maintained. When many of the leading gastric surgeons of the world thus express themselves as in favor of some form of physiologic anastomosis between the stomach and duodenum it seems surprising that such operations are not more common.

The treatment of gastrojejunocolic fistula is surgical. As there is likely to be soiling of the peritoneum where the fistula is undone the procedure should be as simple as possible and usually consists in repairing the fistulous opening and undoing the anastomosis restoring the gastro-intestinal tract to normal. If this alone is not successful pyloroplasty gastroduodenostomy or resection may be done later. In debilitated patients, feeding by jejunostomy may be useful in preparing them for operation. Simple repair of the fistula and undoing of the anastomosis was done in 3 of our cases (3, 6, 21). 1 patient died of peritonitis 13 days after operation the 2 others are both recent cases, but it already seems likely that one of them will require further operation because of obstructive symptoms similar to those he had before his gastro-enterostomy. It is thus evident that gastrojejunocolic fistula is a very serious condition and as it occurs in from 10 to 15 per cent of all jejunal ulcer cases it presents a strong additional argument for early surgery in treating jejunal ulcer.

CONCLUSIONS

The incidence of jejunal ulcer proved by operation at the Massachusetts General Hospital is approximately 2.9 per cent.

Jejunal ulcer is very rare after gastro-enterostomy for gastric ulcer and probably never occurs after gastro-enterostomy for gastric cancer.

The disease is due largely to an improper selection of cases for gastro-enterostomy.

CARCINOMA OF THE TRANSVERSE COLON

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THE literature upon malignancy of the large bowel is prodigious and there is probably no phase which has escaped attention at some time or other. The opportunity of observing a recent case of carcinoma in the mid transverse colon which terminated very favorably has pointed out two aspects of the condition which have perhaps not received due consideration.

It is surprising that malignant tumors of the transverse colon occur with relative infrequency. On analyzing 297 cases of carcinomata of the colon it was found that only 22 or 7.3 per cent were located between the hepatic and splenic flexures.

It is commonly thought that due to the accessibility of this region, operative removal of such tumors is facilitated and the prognosis is good. A careful analysis of this group however reveals a mortality rate higher than is customarily found for growths in other parts of the large bowel. These deaths are due to various causes: some to faulty operative technique, some to unavoidable postoperative complications, and still others to the difficulty encountered in effecting a complete removal.

The 22 cases recorded in this hospital have been reviewed from the standpoints of clinical features, surgical technique and pathology with the intent of discovering the reasons for these peculiarities.

OCCURRENCE

Table I shows the distribution of 297 tumors of the colon in its various parts. The colon is for this purpose empirically divided into five parts: the ascending colon, hepatic flexure, transverse colon, splenic flexure and descending colon (including the sigmoid). Further subdivision seems unnecessary and ambiguous. Bearing in mind that the transverse colon is approximately the same in length as either the ascending or descending portions, it is more than accidental that carcinomata occur about one fifth as frequently in the former location as in either of the latter. A satisfactory explanation for this characteristic is entirely lacking. There is nothing peculiar in the embryology, anatomy or histology which might predispose to the infrequency with which it is invaded. It must be borne in mind however that the transverse colon is functionally more active and that stasis of fecal contents is less likely to

occur. Until the relationship between stasis, irritation and tumor formation is established, however, this cannot be regarded as a responsible factor.

AGE—RACE—SEX INCIDENCE

Carcinomata of the transverse colon are similar in respect to these features to malignancies elsewhere in the large intestine. The age incidence is most commonly in the fifth decade of life, the average age of the group being 44 years. All of the tumors occurred in members of the white race. Fourteen occurred in males and 8 in females, agreeing closely with the sex distribution in all gastro-intestinal malignancies.

CLINICAL FEATURES

The symptoms of carcinoma in the transverse colon are not unlike the clinical manifestations of malignancies elsewhere in the gastro-intestinal tract. The average duration of symptoms is about 14 months. General symptoms experienced by the patient are malaise, loss of weight, secondary anemia, and abdominal pain. More specific symptoms are apparent when obstruction is present, either partial or complete. The patient then complains of eructation, digestive upsets, fullness or distention, meteorism and constipation. When ulceration has occurred, tarry stools are frequently observed.

It is interesting that the symptoms are frequently referable to upper intra-abdominal pathology. In one instance the symptoms were characteristic of an acute cholecystitis. In several cases the symptoms and signs were mistaken for those of gastric malignancy and in none of these was the correct diagnosis made before the abdomen was opened.

The physical signs may be negligible in the early stage of the disease and nothing more than a moderate distention observed. Tumors in this region, however, are usually palpable early and by careful palpation, even a small mass can be picked up against the prominence of the vertebral column. The patients are usually underweight, pale, and undernourished. Laboratory examination reveals a moderate secondary anemia. The stools in many instances are grossly black or bloody and, in the majority, occult blood can be demonstrated. Achlorhydria is commonly associated with carcinomata of the stomach. It is surprising

TABLE I—DISTRIBUTION OF 297 CARCINOMATA OF THE COLON

Location	Cases	Per cent
Cecum and ascending colon	96	32.3
Hepatic flexure	51	7.1
Transverse colon	22	5
Splenic flexure	18	6.4
Descending colon and sigmoid	109	36.7
Location undetermined	31	10.0
Total	297	100.0

TABLE II—METASTASES AND EXTENSION

Metastases	Cases
Glands	5
Liver	6
Extension	
Stomach	8
Omentum	6
Duodenum	1
Ascending colon	1
Gall bladder	1
Small intestine	2

however to find an absence of free hydrochloric acid in a large percentage of carcinomata of the transverse colon.

Diagnosis is usually made by the X ray films following a barium enema. These when positive on repeated examination should be conclusive but it is never amiss to perform a gastro-intestinal series as embarrassing mistakes have been known to occur following the omission of this procedure.

PATHOLOGY

The majority of tumors in this location assume the annular constricting form sometimes aptly described as napkin ring carcinoma. The early growth may appear as a small ulcer on the mucosal surface of the gut wall. The edges are hard and elevated leaving a crater like erosion in the center. The wall is thickened and indurated. As growth progresses the ulcerated area extends around the bowel more rapidly than longitudinal, leading eventually to an annular growth. When this has occurred the tumor continues to grow both longitudinally and inwardly forming a hard encircling band which constricts the lumen until in late cases it is almost entirely occluded.

Extension to the mesentery may take place. Involvement of the mesentery glands is not rare and does not seem to be dependent upon the age of the tumor. Metastases have been observed in very early cases of short duration. The liver is particularly susceptible to metastases and contained secondary growths in 27 per cent of the cases of this series. Extension to adjacent organs occurs and it is not at all uncommon to find on laparotomy a large conglomerate mass of tumor the origin of which is not determined until the specimen is dissected. Extension is particularly apt to involve the stomach in fact this had occurred in 32 per cent of the cases more than had metastasized to either the liver or lymph glands. This brings about complications both in diagnosis and treatment. The symptoms and X ray findings are frequently those of gastric pathology and the correct diagnosis is not usually made before operation. Surgical treatment is

more difficult since a partial gastrectomy is necessary to remove all possibly involved tissue. This extension may travel through the lymphatics of the omentum by which means a surprising number of omental implants occur. More commonly the growth involves the posterior wall of the stomach with which it is partly in contact. Table II shows the location of the metastases and secondary growths.

The microscopic pathology is not distinctive. The majority are adenocarcinomata. It is surprising that a large percentage of cases showed mucoid degeneration in the presence of the adenocarcinoma and were originally diagnosed colloid carcinoma. Such was the case in 60 per cent of the tumors, a much higher percentage than has been encountered in the other portions of the colon. The medullary and scirrhous types of carcinoma may also occur but are far less frequent than adenocarcinoma.

TREATMENT

The treatment of carcinoma of the transverse as well as other parts of the colon should consist of early radical excision. Since this is the most easily accessible portion of the colon the average operator regards the prognosis as good and has a tendency to exercise less care in resection. The results of surgical extirpation in 18 treated cases were not gratifying. Six died as a result of the operation 2 of peritonitis and 4 of pneumonia embolism or shock. Two died of recurrence 3 are well 5 years or more 3 are living without signs of recurrence less than 5 years after operation and 4 were improved following operation but no report as to ultimate result was obtained. Four were thought to be inoperable and eventually died of extension and metastases. Fecal fistulae developed in 4 cases. In all of these catgut was used in suturing the blind ends. It is the experience of several operators that heavy silk is safer than catgut at this site. Table III shows the results of treatment in this group of cases.

The anatomy of the transverse colon should be reviewed briefly before further approaching the

TABLE III—RESULTS OF TREATMENT

	Cases
Improved following operation, but lost	4
Well less than 5 years following operation	3
Well 5 years or more	3
Dead—postoperative	
Peritonitis	2
Pneumonia	2
Embolism	1
Postoperative shock	1
Dead from recurrence following operation	2
Inoperable, palliative treatment only	4
Total	22

surgical treatment. Its general direction is transversely across the abdominal cavity with a variable degree of ventral and caudal convexity. It is supported by the transverse mesocolon the continuation of which forms the inferior leaf of the greater omentum. This is directly overlying the colon and in approximation to it. Near the hepatic flexure it is not entirely covered by peritoneum but overhes the right kidney and duodenum. Near the splenic flexure the mesentery is longer and allows more mobility. The splenic flexure is higher and more posterior than the hepatic. The blood supply is furnished largely by the middle colic artery arising from the superior mesenteric. It arches to the right, supplying the hepatic flexure and ramifies in the region of the splenic flexure with the left colic. The course of the middle colic is variable, but it usually curves upward about 6 to 8 centimeters to the right of the midline.

Bearing in mind these anatomical features, the mode of surgical procedure must be approached. Two methods of removal are open to the operator local resection and resection of the entire right half of the colon with an ileocolic anastomosis.

When the tumor is located in the middle or left half of the transverse colon, local resection may be practised with impunity inasmuch as the intestine can be mobilized and anastomosis facilitated. A common mistake of resection is the removal of too much bowel, leaving short stumps upon which considerable tension must be exerted to obtain approximation. Some pathologists claim to have found evidence of malignant change in the intestinal wall, 2 inches or more from the site of the primary growths. No doubt this may be true in advanced cases but in early operable cases this statement is open to question. It is the author's impression that the removal of a wide margin of normal gut is frequently overrated. A second and perhaps more important technicality lies in the preservation of the blood supply. Meticulous care should be exercised in choosing

the point of resection so that viability of both stumps is preserved. This necessitates careful dissection of each branch of the middle colic artery which in some instances is especially difficult due to an excess of fat in the mesentery. Therefore three factors must be considered in choosing the point of resection, the blood supply the mobility of the bowel, and the proximity to the tumor.

Two methods of anastomosis are available the end-to-end and the lateral. The end-to-end method may be used in some cases with success, but in general is not as satisfactory as the lateral method. It requires more exacting surgical technique and the chance of leakage following anastomosis is greater. The operator may be governed by circumstance and if it is impossible to overlap the bowel without undue tension, the end-to-end method must be used. The anastomosis devised by Parker and Kerr is frequently used and is more satisfactory than the older open method.

Whenever possible the lateral anastomosis is preferable. A larger stoma is formed and there is less chance of obstruction. There are two satisfactory methods of performing this union. The first is the isoperistaltic anastomosis and is in general satisfactory except for two features. Blind pouches are left, necessitating obliteration by suture to the opposing lumen. In spite of this precaution damming up of fecal contents sometimes occurs which may cause either perforation or occlusion of the stoma. The anastomosis is dropped back into the peritoneal cavity after the operation. Should gangrene or perforation occur peritonitis is likely to result. Bloodgood devised a method to overcome this feature in 1906. He performed an antiperistaltic lateral anastomosis, but brought the blind ends out through the peritoneum when closing the wound. This method extraperitonealizes the weak blind ends and in the event of gangrene or rupture, infection takes place outside the peritoneal cavity. Thereafter nothing more harmful than a fecal fistula results which can be closed at a later date.

If the tumor is located in the proximal half of the transverse colon, the entire right half of the colon may be removed. The description of this technique can be found in all treatises on operative surgery and need not be repeated here. It involves freeing the cecum and ascending colon from the peritoneal attachments and resection of the right half of the colon together with a portion of the terminal ileum. The raw surface left is then peritonealized and a lateral anastomosis performed between the terminal ileum and the distal

transverse colon. In the hands of competent operators this is a relatively safe procedure and the operative mortality is surprisingly low. It is a longer operation and consequently attended by greater shock. The removal of such a large portion of gut results in a moderate physiological disturbance of the bowel which may not become readjusted until some months after the operation. Nevertheless it is considered an excellent operative procedure both from the standpoint of radical removal of possibly involved glands and a functionally good anastomosis.

The use of radium and deep X ray therapy has been found no more efficacious in carcinomata of the transverse colon than in other portions of the bowel, for the reason that adenocarcinomata are not radiosensitive. While it is true that irradiation may sometimes give temporary relief in late inoperable cases it rarely brings about any lasting improvement. A short circuiting operation is more desirable for the relief of obstruction.

The prognosis of carcinomata of the transverse colon should be comparable to that of carcinomata elsewhere in the gastro-intestinal tract with observation of the above mentioned technical factors. The tendency toward invasion of the stomach jeopardizes the operability but emphasizes the need for thorough examination including a gastro-intestinal series and barium enema whenever there are symptoms of intra-abdominal pathology. Far too frequently is the complete X ray examination omitted either through negligence or the desire of the physician to spare the patient discomfort in the examination or a seemingly unnecessary expenditure.

CASE REPORTS

Detailed case reports all too often confuse the reader and lend ambiguity to a surgical paper. It is the author's intention to avoid this so far as possible, but with a relatively small number of cases there are certain illustrative features which can be brought out only by a brief case history. In the subsequent reports, only those features which are of direct importance in the diagnosis and treatment of the cases are included.

CASE 1. Path. No. 45848. White female, aged 53 years. The patient had complained of headaches, constipation, and weakness for 3 years. She had felt a subjective obstruction to the bowels for 3 months and had lost 18 pounds in weight during the illness. Physical examination revealed a palpable, tender mass just above and to the right of the umbilicus. The patient was markedly anemic. An irregularity was seen in the middle of the transverse colon with the fluoroscope and in the X-ray plates. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was performed September 5, 1931. Six inches of the intestine were removed with a V-shaped piece of

mesentery for a hard constricting tumor located in the middle of the transverse colon. The mesentery contained several enlarged lymph glands. The ends of the intestine were anastomosed laterally by the "thumb" method of Bloodgood. Pathological diagnosis: adenocarcinoma, grade II with mucoid degeneration. The glands were negative for metastases. One of the blind ends broke down on the tenth day after operation with the subsequent formation of a fecal fistula. This drained persistently for several weeks but was finally closed and the patient was discharged 3 months after operation. She is well at the present time, 8 months after operation.

This patient fortunately recognized the subjective signs of obstruction before the tumor became inoperable thereby enhancing the chances of recovery. The advantages of the thumb anastomosis devised by Bloodgood are illustrated by the rupture of the blind end of bowel with a subsequent fistula. Had this occurred within the abdominal cavity a generalized peritonitis would have developed with a probable fatal termination. The condition of this patient became critical during the operation the blood pressure falling and the pulse rising. The operator, having a donor previously matched for blood transfusion, administered 500 cubic centimeters of citrated blood to the patient on the table, with the result that she left the table in excellent condition and suffered little postoperative shock. This measure if practised more frequently would no doubt avert many postoperative deaths from shock after severe operations.

CASE 2. Path. No. 44223. White female aged 56 years. The patient had suffered abdominal pain, nausea, and vomiting for 3 months and was conscious of an abdominal mass for 3 months. She had lost a moderate amount of weight. Physical examination revealed a tender palpable mass in the midline below the umbilicus. It was the size of a grapefruit with a discharging sinus. The X ray examination showed in the mid transverse colon complete obstruction to the barium enema. Pre-operative diagnosis: carcinoma of the mid-transverse colon.

Operation was done December 8, 1928. A large tumor mass was found within the sac of a ventral hernia. It was resected and the hernial defect repaired. The tumor was not attached and no enlarged glands were found. Pathological diagnosis: adenocarcinoma, grade IV, with fistulous communication to the bowel. Patient died 14 days after operation from infection of the abdominal wall and pulmonary embolism.

It is unusual that a tumor giving rise to symptoms for only 3 months could have attained this size. The patient was either unaware of pre-monitory symptoms or the tumor grew with extreme rapidity. The coincidence of a ventral hernia with the tumor no doubt confused the patient, for having the previous condition for a number of years she in all probability attributed her symptoms to it.

CASE 3. Path. No. 38244. White male, aged 33 years. The patient had suffered moderate gastro-intestinal dis-

orders for 3 months and had lost 25 pounds. He had been conscious of an abdominal mass for 3 months. The last 3 weeks of his illness were characterized by a mucous diarrhoea of foul character. Secondary anemia and cachexia were marked. A firm, tender movable mass the size of a lemon was felt below the umbilicus. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was done December 8, 1923. An annular, necrotic tumor was found in the colon extending to and involving the stomach, omentum, and mesentery. The tumor was resected together with a portion of the mesentery, omentum, and stomach wall. The bowel was joined by an end-to-end anastomosis and the stomach defect was closed. Pathological diagnosis: adenocarcinoma, grades II and III, arising in the left transverse colon. Patient died 9 hours after operation from postoperative shock.

The failure of the first physician consulted to suspect the malignancy emphasizes the tremendous importance of thorough gastro-intestinal studies in all cases of obscure disorders. This calls for an extreme nicety of judgment in deciding what examinations must be made and when since it is obvious that every case of indigestion should not be subjected to the routine examination, not only on account of the discomfort to the patient, but for economic reasons as well.

CASE 4. Path. N. 37357. White female, aged 60 years. This patient suffered from intermittent cramp-like pains for several months during which a small movable lump would sometimes be seen. Blood was seen in the stools on several occasions, and the patient had three transient attacks of jaundice. Physical examination disclosed a movable, non-tender mass about 7 by 12 centimeters in size, palpable in the upper right quadrant. There was an absence of free hydrochloric acid. A roentgenographic filling defect could be seen in the transverse colon. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was done May 18, 1925. A small tumor was found in the transverse colon which was freely movable. It was removed together with a portion of the transverse colon and a portion of the mesentery. The ends were anastomosed by the Parker-Kerr method. Pathological diagnosis: polypoid adenocarcinoma, grade II, with mucoid degeneration, no glandular metastases. Transient symptoms of obstruction appeared on the fifteenth day after operation, but soon disappeared. The patient was discharged well 3 weeks after operation. No ultimate result note was obtained.

The jaundice in this case could be caused by either the extension of the tumor to the periductal lymph nodes or a coincident and irrelevant condition. The obstruction after operation was probably due to a temporary volvulus or kink of the intestine. But its spontaneous disappearance rendered the complication of little significance.

CASE 5. The patient suffered weakness, anorexia, and hematuria, which led to the diagnosis of pyelonephritis and a subsequent nephrectomy which was done 4 months before present admission to the hospital. He improved slightly following this operation but suffered an exacerbation of the symptoms later with a pronounced cachexia and loss of weight. Physical examination dis-

closed a moderate distention of the abdomen with a rigidity of the abdominal muscles. Several indefinite masses were palpated in the upper abdomen. There was a hyperchlorhydria and a secondary anemia. Roentgenograms showed a defect in the greater curvature of the stomach and a spastic condition of the right transverse colon. Pre-operative diagnosis: carcinoma of the stomach.

Operation was done December 8, 1924. An exploratory laparotomy revealed an inoperable carcinoma of the distal transverse colon with metastases to the liver. Pathological diagnosis: carcinoma of the transverse colon, pressing on the stomach; no specimen removed. The patient recovered from the immediate effects of the operation but died a few months later from the extension of the disease.

The presence of a kidney lesion no doubt obscured the tumor symptoms in this case. Had there been no other pathology, the gastro-intestinal condition would have been diagnosed sooner and the tumor approached while in its operable state. The hyperchlorhydria is unusual since many cancers of the large bowel are characterized by an achlorhydria. This case illustrates the frequent confusion noted in diagnosing carcinomata of the transverse colon. The roentgenographic examination indicated a lesion of the stomach but this was apparently caused by a tumor mass in the colon producing a secondary irregularity while the absence of the typical constricting tumor in the colon left it free from roentgenographic defects.

CASE 6. Path. No. 35773. White male, aged 45 years. Intermittent lower abdominal pain had been noticed for 3 years. Exploratory laparotomy 1 year before admission revealed multiple tumors in the bowel. Following this the patient was temporarily improved but had a subsequent recurrence of symptoms with increased severity, hiccoughs, dysuria, and loss of weight. Clinical examination revealed visible peristaltic waves and meteorism. A crater shaped ulcer was found in the rectum. A secondary anemia was present and there was a roentgenographic defect in the transverse colon. Pre-operative diagnosis: carcinoma of the mid-transverse colon.

Operation was done August 4, 1924. The entire right colon was resected for a large mass arising in the mid-transverse colon and adherent to the stomach, gall bladder and omentum. Several isolated polyps were found in the removed bowel. A lateral ileocolostomy was then performed. Pathological diagnosis: adenocarcinoma, grade III, mid-transverse colon; multiple benign polyps. A fecal fistula formed in the scar which refused to heal and the patient was discharged unimproved at his own request and no subsequent note has been available.

The multiple polyposis was apparently regarded by the first operator as a benign condition, and no attempt was made at operative removal. The treatment of choice would have consisted of removal of all the involved bowel, since carcinomatosis is a frequent coincident condition. Multiple carcinomata are rare and furnish the main argument in favor of malignant change in previously existing benign polyps.

CASE 7. Path. No. 33606. White male, aged 38 years. The patient had suffered weakness, loss of weight and anorexia for 7 months with dull epigastric pain increasing in severity and frequency for 3 months. Nausea and vomiting, melena and diarrhea were present for 1 month. Physical examination disclosed a moderate abdominal rigidity, gastric achlorhydria, and secondary anemia. A fistulous communication between the stomach and transverse colon was visible in the X-ray plate following a barium enema. This arose at the site of a filling defect in the colon. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was done March 31, 1923. A portion of the transverse colon and a section of the stomach wall were resected for a large friable polypoid growth arising from the colon and extending to the stomach. The continuity of the colon was re-established by lateral anastomosis and the defect in the stomach closed. Pathological diagnosis: adenocarcinoma, grade II with mucoid degeneration; glands were negative for metastases. The patient died 7 days after operation from generalized peritonitis.

When a cancer has advanced to the stage illustrated by this case the outlook is extremely poor. The operation is long and difficult and even with the most perfect technique is hazardous. This is another of the cases in which the tumor grew rapidly and involved the stomach but in which in addition a fecal fistula had formed.

CASE 8. Path. No. 33633. White male, aged 63 years. Alternating constipation and diarrhea had annoyed the patient for 3 years. During this time he had sometimes been conscious of an abdominal mass. He suffered frequent attacks of colic like pain, which were often relieved coincident with a squirting sensation. He had lost considerable weight. A hard tender movable mass the size of an orange was noticed below the umbilicus. Free hydrochloric acid in the gastric contents was not noted. A roentgenographic defect was visible in the first third of the transverse colon. Pre-operative diagnosis: malignancy of large bowel.

Operation was done August 7, 1923. A large mass arising in the transverse colon extending to the stomach and adherent to the omentum and small intestine was removed by resecting a portion of the transverse colon and a piece of the stomach wall. After separating the mass from the other involved structures, a lateral anastomosis of the colon was performed and the defect in the stomach closed. Pathological diagnosis: adenocarcinoma, grade III with mucoid degeneration. The patient died 14 days after operation from pneumonia.

The patient's own description of his condition is oftentimes invaluable. For instance this patient stated that he felt a 'squirting' sensation which relieved pain and distention. Obviously this could be caused by nothing other than partial obstruction of the bowel allowing only small amounts of fecal material to pass at a time. Of similar value is the patient's description of a taste of hard boiled eggs following eructation and regurgitation. The flat taste of acid free stomach contents is immediately suggestive of achlorhydria. One patient complained that his clothes fitted too tightly so that he was not able to wear his belt comfortably but at the same time he

was losing weight. These features pointed to a moderate, almost imperceptible distention but persistent and sufficient to acquaint the patient with an unnatural condition in his abdomen.

CASE 9. Path. No. 33217. White female, aged 45 years. The patient had suffered vague attacks of indigestion marked by cramping pains and bloating sensation for 1 year. At the most recent attack 1 week before admission, she vomited food material ingested 3 days previously. She had lost 15 pounds in weight. A moderate fullness of the abdomen was evident and roentgenographic filling defect was present in the left transverse colon. Pre-operative diagnosis: carcinoma of the large bowel.

Operation was done June 9, 1923. At exploratory laparotomy an inoperable carcinoma was found arising in the left transverse colon involving the stomach and adherent to the parietal wall. A palliative colocolostomy was performed. Pathological diagnosis: carcinoma of the transverse colon, no glandular metastases. The patient died in 3 months' time from an extension of the disease.

It is unfortunate that often the symptoms brought about by these cancers are so mild that the patient is not alarmed before the disease has advanced to an inoperable stage. An excision could have been attempted but since so few cases involving the stomach wall recover, the operator displayed good judgment in doing nothing more than a palliative operation thereby giving the patient freedom from symptoms during the remaining months of her life.

CASE 10. Path. No. 57807. White female, aged 70 years. This patient complained of constipation for 10 months, during which time she was frequently nauseated and sometimes vomited fecal material. Gastro-intestinal series 5 months before admission was negative. Physical examination disclosed a superficial resistance in the upper left quadrant overlying a definitely outlined mass, which was irregular in shape, fixed and tender. There was a roentgenographic obstruction just proximal to the splenic flexure. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was done October 5, 1922. At exploratory laparotomy an inoperable tumor was found arising from the transverse colon, adherent to the jejunum and stomach. It was the size of an orange, was nodular and hard, and metastatic nodules were found in the omentum and liver. Pathological diagnosis: carcinoma of the transverse colon; no specimen was obtained. The patient died 5 months after operation from extension of the disease.

Spasticity of the colon not infrequently produces an obstruction which can be mistaken for an organic lesion by the X-ray findings alone. Therefore, it is important not only to repeat the gastro-intestinal series but to observe the patient fluoroscopically as well.

CASE 11. Path. No. 50673. White male, aged 45 years. The patient suffered from intermittent pain in the left lower quadrant and a marked diarrhea for 8 months following an operation for acute intestinal obstruction. He was sometimes conscious of a mass in the left side during an attack. Physical examination revealed the abdomen tympanitic

and tender to palpation on the left side. A roentgenographic defect was present near the splenic flexure in the transverse colon. Pre-operative diagnosis: partial obstruction due to peritoneal adhesions.

Operation was done June 15, 1922. A tumor the size of a lemon was found in the left transverse colon attached to the stomach. It was freed and resected together with adequate normal bowel and a lateral anastomosis performed. Pathological diagnosis: adenocarcinoma, grade I, with mucoid degeneration; no glandular metastases were found. The patient was discharged well 3 weeks after the operation.

It is remarkable that although symptoms had been present before the first operation, no tumor was found. Evidently it must have been present at that time and was overlooked at exploration. Fortunately for the patient it was of low grade malignancy and in spite of delayed removal a good result was achieved. Too much emphasis cannot be laid on the necessity of a thorough exploration at every laparotomy.

CASE 12. Path. No. 23466. White male, aged 60 years. Three years before admission a local physician had found in the abdomen a mass which had increased very little in size. Pain, jaundice, vomiting, and cachexia had been present 1 year. At physical examination an indefinite, slightly tender mass was felt in the upper right quadrant. Roentgenograms showed an abnormal position of the intestines in this region due to an extra luminal mass. Secondary anemia was marked and occult blood was found in the stools. Pre-operative diagnosis: malignancy of the large bowel.

Operation was done July 9, 1921. A tumor the size of an orange in the right transverse colon, was resected with a piece of mesentery containing several large glands. The bowel was anastomosed by the end-to-end method. Pathological diagnosis: adenocarcinoma, grade I, with mucoid degeneration; glands negative for metastases. Patient was well 10 years after operation.

It is difficult to understand why the first physician consulted allowed this patient to continue without hospitalization for 3 years following the first appearance of the mass. It is perhaps another case in which the patient is alarmed by symptoms of discomfort rather than the presence of an abnormal mass. A gratifying result following the removal of a mass of this duration is unusual and was no doubt due to its extremely low grade of malignancy.

CASE 13. Path. No. 28670. White male, aged 53 years. For 6 weeks this patient had suffered intermittent cramp-like pains and meteorism. Malaise and anorexia accompanied these symptoms. At physical examination indefinite peristaltic waves and a definite bulging mass at the umbilicus were visible. This mass was firm, nodular and freely movable but not painful. Pre-operative diagnosis: carcinoma of the large bowel.

Operation was done February 25, 1921. A tumor was found in the mid portion of the transverse colon. This was resected with 5 inches of normal bowel on either side and a V-shaped piece of mesentery including several enlarged glands. A lateral anastomosis was performed between the

blind ends. Pathological diagnosis: adenocarcinoma, grade II, with mucoid degeneration; the glands showed no metastases. The patient was well 8 months after operation, but no further information was obtained.

This patient's symptoms were not severe. The neuroathenic patient usually causes the physician no end of trouble by his magnification of minimal symptoms but it is to be said in their favor that few neuroathenics die of cancer. This patient in spite of his mild symptoms sought the advice of his physician early. If every patient recognized the possible significance of premonitory symptoms the death rate from cancer would be considerably lower.

CASE 14. Path. No. 25276. White male, aged 54 years. Pain in the left side had been present intermittently for 7 months, and the patient was conscious of an abdominal mass for 4 months, before admission. The stools were frequently black and tarry. Occult blood in the stools comprised the only positive finding on physical examination. X-ray examination was negative but an exploratory laparotomy was deemed expedient. Pre-operative diagnosis: deferred.

Operation was done November 5, 1916. A small, annular carcinoma was found in the transverse colon. It was resected and the bowel ends joined by lateral anastomosis. Pathological diagnosis: adenocarcinoma, grade II, with mucoid degeneration. The patient remained well for a year, then returned with numerous metastases to the liver and stomach from which he died a few months later.

It has been said by eminent surgeons that one of the justifications of laparotomy is to establish a diagnosis. This brings about many unnecessary operations but in a few cases such as Case 14, has made possible the diagnosis of a lesion of great significance. There was little in the clinical history to indicate a carcinoma. One should be suspicious, however, when pain of a dull aching character is more or less constant over a number of months. It is unusual for malignancy to recur in the bowel as late as 4 years, and naturally one suspects the presence of a new tumor but since no autopsy was performed this point remained unsettled.

CASE 15. Path. No. 29763. White male, aged 41 years. A subjectively noticeable mass had been present in the right side for 6 weeks, causing moderate pain, dull and aching in character. In the upper right quadrant a hard nodular tender mass could be felt. Roentgenograms showed an obstruction in the first third of the transverse colon. Pre-operative diagnosis: malignancy of large bowel.

Operation was done January 30, 1918. The entire right half of the colon was resected together with the terminal ileum for a large mass arising from the transverse colon and involving the duodenum and ascending colon. Pathological diagnosis: medullary carcinoma without metastases. The patient was discharged from the hospital well but no ultimate result note was obtained.

Resection of the first half of the colon is sometimes a beneficial procedure. In this case the

tumor had involved the ascending colon and it was thought expedient to remove as much bowel as possible. The operation involves little more technical difficulty than simple resection and frequently gives a much better result.

CASE 16. Path. No. 18672. White male, aged 47 years. For 3 months the patient had suffered from cramp-like pains in the abdomen and a sensation of fullness. He had been moderately constipated and vomited twice. Gaseous eructation and regurgitation which was at first acid in taste, changed to a fecal character. He had lost 15 pounds. Peristaltic waves were seen in the upper abdomen, most prominent on the left side, where there was a superficial resistance in the abdominal wall. A gastro-intestinal series of roentgenograms indicated a pyloric obstruction with 24 hour retention. Pre-operative diagnosis: carcinoma of the pylorus.

Operation was done December 24, 1915. When the abdomen was opened the operator found a huge mass in the region of the gall bladder arising from the transverse colon and involving the stomach and gall bladder to such an extent that removal was out of the question. A palliative gastro-enterostomy was performed. Pathological diagnosis: carcinoma of the transverse colon. No specimen was obtained. The patient was discharged in 18 days improved, but died 4 months later with extension of the disease.

This patient showed symptoms of upper abdominal pathology which justified the diagnosis of carcinoma of the stomach. The presence of gall stones confused the picture but in spite of this a lesion in the lower tract was indicated by the characteristic fecal vomiting.

CASE 17. Path. No. 17777. White female aged 69 years. The patient had suffered intermittent attacks of pain and vomiting which were partially relieved by emetics for 6 months. The attacks increased in frequency and severity. She had lost some weight. The abdomen was found to be moderately distended and just to the left of the umbilicus was felt an indefinite slightly tender mass. Pre-operative diagnosis: malignancy of the bowel.

Operation was done May 20, 1914. On exploration a hard, annular tumor was found in the transverse colon. It was resected with the customary V-shaped piece of mesentery after ligation of the main branches of the colic vessels. The blind ends were anastomosed by the method of Bloodgood. Pathological diagnosis: adenocarcinoma grade III, encircling the lumen and producing partial obstruction. One of the blind ends broke down 8 days after operation with a resulting fecal fistula. This closed itself 5 weeks after operation. The patient was well when last heard from 5 years after operation.

Very few patients seek medical advice for constipation. It is nevertheless one of the most valuable and constant symptoms of gastro-intestinal tumors. Many individuals are constipated but very few over 40 years of age have a sudden and constant change of bowel habit without an underlying cause. This case illustrated again the advantages of 'Bloodgood's thumb anastomosis.'

CASE 18. Path. No. 14519. White female, aged 64 years. This patient had suffered from occasional attacks

of cramp-like pain for 3 months. She had lost 18 pounds in weight. When examined on entrance to the hospital the patient was evidently suffering from an acute obstruction. She was vomiting and in acute pain. The abdomen was extended and tympanitic. Pre-operative diagnosis: acute intestinal obstruction.

Operation was done July 21, 1913. A colostomy was immediately performed to relieve the obstruction. At exploratory laparotomy 10 days later a small growth was found at the junction of the first and middle thirds of the transverse colon causing a complete obstruction. The tumor was mobilized and removed after the method of Mikulicz, in two stages. Pathological diagnosis: adenocarcinoma grade IV surrounding the bowel and producing almost complete obstruction. The patient returned to the hospital 5 years later with a recurrence of the tumor in the psoas muscles. She died shortly after the second admission.

Carcinoma of the transverse colon do not customarily produce complete obstruction. When this occurs the underlying condition is apt to be overlooked and recognized only at operation. Two stages of operation are necessary in most cases, the preliminary colostomy for relief of obstruction preparatory to removal at the second. On the other hand certain operators feel that the patient suffers less from one operation and therefore remove the tumor when the abdomen is first opened.

CASE 19. Path. No. 12784. White male aged 42 years. The patient had definite attacks of obstruction lasting 1 or 2 days at a time for a period of 2 weeks, increasing in severity and frequency. Six days before admission he became conscious of a mass in the middle of the abdomen. Constipation was marked and he suffered discomfort following the ingestion of solid food. He had lost an indefinite amount of weight. Examination disclosed a definite hard, immovable mass on the left side of the iliac fossa. Other examinations were negative. Pre-operative diagnosis: malignancy of the bowel.

Operation was done May 15, 1912. The operator found on opening the abdomen a small annular tumor in the distal third of the transverse colon with enlarged glands in the mesentery. The tumor was resected and the ends of the bowel anastomosed by the lateral method. Pathological diagnosis: scirrhous carcinoma surrounding and constricting the intestine; metastases present in the enlarged gland. The patient died 14 days after operation from bronchopneumonia.

The scirrhous type of tumor, that is to say the epithelial tumor characterized by a heavy fibrous reaction is most frequently responsible for constriction. This type of tumor is difficult to demonstrate by palpation but causes its symptoms early and metastasizes late. It is therefore, one of the most favorable types to treat. The death from pneumonia in this case was not the fault of technique, and the autopsy showed a cleanly healed anastomosis.

CASE 20. Path. No. 12331. White male, aged 58 years. This patient suffered attacks of dyspepsia for a number of years. Three weeks preceding his admission to the hospital he had an acute exacerbation characterized by eructation and copious vomiting. Examination disclosed a

bulging mass in the right iliac fossa which was tense and at times showed peristaltic waves. This was tympanic on percussion. A ray examination revealed a dilated cecum with obstruction at the first third of the transverse colon. Pre-operative diagnosis: malignancy of the transverse colon.

Operation was done January 1, 1932. On opening the abdomen the operator found the cecum tremendously dilated, the result of an obstructing tumor mass in the transverse colon. He removed the right half of the colon *in toto* and performed an ileocolic anastomosis. Pathological diagnosis: adenocarcinoma, grade II with mucoid degeneration. The patient died 8 days after the operation from generalized peritonitis.

When markedly distended the wall of the cecum is thinned to such an extent that an anastomosis is hazardous in view of the possible leakage. In Case 30 this fact led the operator to remove the entire right colon. In spite of this precaution however the patient died of generalized peritonitis.

CASE 31. The patient had suffered increasingly severe attacks of pain in the lower abdomen for 6 months. She had lost 20 pounds in weight 3 weeks preceding admission. The bowel that he had suspected a mass in the lower pelvis. She admitted to an acute obstruction. The patient entered the hospital in agony. The abdomen was distended tympanic and extremely tender. Pre-operative diagnosis: acute intestinal obstruction.

Operation was done August 5, 1929. The operator performed a laparotomy rather than a preliminary lumectomy. It found in the left half of the colon a mass which had completely encircled the lumen causing almost complete obstruction. The tumor was resected with an adequate margin of normal bowel and a Y-shaped part of mesentery containing a few enlarged glands. The bowel ends were anastomosed with the end-to-end method. Pathological diagnosis: adenocarcinoma, grade II of the obstructing "napkin ring" type; the glands were negative for carcinoma. The patient suffered partial obstruction following the operation for 2 years. At a second operation adhesions were released which had caused a partial obstruction of the site of the anastomosis. The patient is well at present 4 years after the first operation.

In this case the operator felt justified in doing the excision at the first operation. The fact that the patient did not recover entirely does not discredit the method of procedure.

CASE 32. Path. N. C-5074. White female aged 66 years. This patient had noticed an upper abdominal mass for 3 years. For 2 years previous to admission she had been annoyed by a persistent diarrhea. The mass had steadily increased in size but was not painful. She had lost 15 pounds in weight. Examination revealed a mass in the upper midline the size of an orange, which seemed to be adherent to the transverse colon and omentum. Pre-operative diagnosis: carcinoma of the transverse colon.

Operation was done June 3, 1933. On opening the abdomen the operator found a mass 3 centimeters in diameter surrounding the transverse colon in its middle portion but producing very little obstruction. This mass was resected with a few centimeters of normal bowel on each side and a section of the mesentery. The ends of the bowel were anastomosed by the end-to-end method. A portion of the

ileum adherent to the tumor was also resected. Pathological diagnosis: adenocarcinoma grade IV, transverse colon. The patient was discharged well and to date 4 years later has had no sign of recurrence.

This case again represents the type of patient who allows an abnormal mass to go unobserved for 5 years and consults a doctor only when symptoms occur which interfere with his daily activity. Modern medical teaching advocates early consultation for suspicious symptoms. The education of the laity leaves much to be desired and until patients learn to seek medical advice not only for annoying symptoms but also for any abnormal growth or condition, the ability of the physician to help them is lessened.

SUMMARY

Carcinoma are relatively rare in the transverse colon only 7.3 per cent of all carcinomas of the colon being located in this region.

The clinical features differ little if any from those of carcinoma elsewhere in the bowel. Symptoms frequently simulate those of upper abdominal pathological conditions, such as gastric lesions or gall-bladder disease and confusion of diagnosis is not rare. An achlorhydria is found in the majority of cases. Diagnosis is made by X-rays following both a barium meal and a barium enema. In cases in which the findings are doubtful the series should be repeated.

It is surprising to find that tumors arising from the transverse colon involve the glandular system relatively infrequently. Metastases have a predilection for the liver. More common than metastases, however is direct extension to the stomach and omentum, thereby causing the condition to be confused with carcinoma of the stomach. The majority of these tumors assume an annular constricting form and cause symptoms of partial obstruction.

Histologically most of the tumors are of the adenocarcinoma type with secondary mucoid degeneration. This accounts for their tendency toward extension to adjacent structures with increased operative difficulty.

The optimum treatment consists of early radical resection followed by anastomosis. The operator should give particular attention to the amount of bowel resected, the preservation of blood supply to the stumps, the prevention of tension on the anastomosis, and the method of anastomosis. Lateral anastomosis is to be preferred to the end-to-end method. The isoperistaltic or thumb method of anastomosis devised by Bloodgood is an advantageous procedure when sufficient bowel can be obtained without tension. This method

allows a possible rupture of the blind ends to take place outside the peritoneal cavity without causing peritonitis.

The results of treatment in 22 cases have not been gratifying. Five year cures have resulted in only 3 cases and cures of shorter duration in the same number. Postoperative deaths were 6 and

deaths from inoperability or recurrence numbered 6.

The evaluation of early symptoms by the clinician with a resultant early diagnosis and careful attention to the above mentioned technical factors by the surgeon should enhance the patient's chances of recovery.

PUNCH BIOPSY IN TUMOR DIAGNOSIS

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IN a previous communication¹ the author described a new technique and instrument for obtaining biopsy specimens and reported the results obtained with it in the diagnosis of twenty tumors. Since the publication of that paper the design of the instrument has been improved and an additional series of cases has been accumulated. This paper will describe the new punch, its advantages, technique of its use, methods of preparing the material obtained, and the results attained in the biopsy of 100 tumors.

The new punch consists essentially of three parts:

1. A tubular sheath fitted by a set screw to a forceps-type handle bearing a yoke which provides longitudinal movement to a specimen cutter operating within the sheath.

2. A specimen cutter, the lance pointed tip of which serves as a trocar when the instrument is held in the closed position.

3. An insulated electrode, the diameter and length of which are such that it may be introduced through the sheath and project beyond its end.

The sheath (Fig. 1) is a hollow metal cannula 12 centimeters long and 3 millimeters in diameter. Its distal end is ground to a circular cutting edge; its proximal end terminates in a tapered ferrule which is fitted to the handle by means of a set screw. The ferrule will accommodate the tip of a Luer syringe.

The specimen cutter (Fig. 1) is a cylindrical rod 15 centimeters long and 2.5 millimeters in diameter, fitting snugly within the sheath. Its proximal end terminates in a knurled knob and immediately distal to the knob is transfixed by a cross pin which engages in the yoke of the movable handle.

By this means the specimen cutter can be extruded from or withdrawn into the sheath. The distal end of the cutter is ground to a sharp, lance point, and when the handles are closed, projects beyond the sheath to form a trocar. Immediately proximal to the lance point the shaft is cut away so as to form a hook 5 millimeters long, the sharp edges of which fit snugly against the edge of the sheath when the cutter is withdrawn into it, thus exerting a shearing action on anything caught between the jaws of the cutter and the sharpened edge of the sheath. The forceps type handle consists of two limbs provided with finger holes and so pivoted that approximation or separation of the handles causes retraction or extrusion of the specimen cutter.

The electrode (Fig. 1) is a slender conductor 18 centimeters long and 2 millimeters in diameter, capable of being introduced through the interior of the sheath and of being extended about 15 centimeters beyond its edge. It is insulated over its whole surface except at its distal extremity where it terminates in a hemispherical knob 2 millimeters in diameter. The proximal end is fitted with a standard insulated split connector designed to receive the connecting cable tip of a source of coagulating (surgical diathermy) current.

TECHNIQUE OF PUNCH BIOPSY

The skin and tissues overlying the suspected tumor are infiltrated with novocain and some of the anesthetic is injected deeply along the proposed path of the instrument, puncture of the tumor being avoided however. A 3 millimeter stab wound is then made through the skin with a sharp pointed bistoury. With the punch closed so that the cutter is withdrawn into the sheath, only the sharp lance point being left exposed, the instrument is introduced through the puncture

¹Hoffman, William J. New technique and instrument for obtaining biopsy specimens. *Ann. J. Cancer* 93: 25, 2.

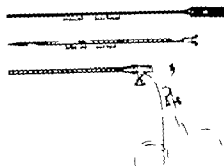


Fig. 1. The three parts of the biopsy punch: insulated electrode, specimen cutter, sheath fitted to forceps-type handle.

wound and thrust through the subcutaneous tissue into the tumor. When the point is felt within the tumor at the site selected for biopsy, pressure is made on the knob of the specimen cutter and the handles allowed to open. This causes the exposure of the hook-shaped cutter. Gentle outward traction causes the hook to imbed itself into the tumor. The handles are then closed, thus causing the cutter to be withdrawn into the sheath and cleanly cutting away the tissue caught between the cutter and the sheath. The cutter is then completely withdrawn with its contained specimen through the inside of the sheath without contaminating the intervening normal tissues, leaving the sheath in position. If additional tissue is desired, the cutter is reintroduced and as much tissue as may be required is removed through the same puncture without an additional breach being made in the tumor. The insulated electrode, connected to a source of coagulating current, is then introduced through the sheath so that the tip of the electrode occupies the point on the tumor from which the specimen was cut away. A current of about 250 milliamperes is switched on, the electrode is held in contact with the area for about 2 seconds, and then slowly withdrawn with

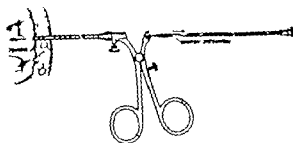


Fig. 3. Specimen is withdrawn through the sheath without contaminating the normal intervening tissues, leaving the sheath in place.

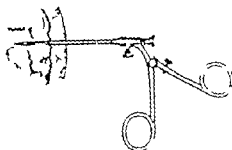


Fig. 2. The punch introduced through puncture wound and the cutter extruded into the tumor ready to cut specimen.

the punch so that a thin film of coagulation is produced along the needle track.

Biopsy of cyst wall. If, when the punch is introduced, there is a sudden loss of resistance and the suspicion verified that the tumor is a cyst, the cutter is extruded within the cyst cavity and then drawn outward slightly so that the hook is imbedded into the proximal wall. Closure of the handles causes the cutter to punch out a portion of the cyst wall, and the specimen thus obtained may be drawn out through the sheath in the usual way. The cyst contents may be allowed to drain out through the sheath. If the fluid is too viscous to flow readily, the handle of the punch should be disconnected so as to permit the attachment of a syringe to the proximal end of the sheath and the aspiration of the contained material. If desired, opaque media may be introduced through the sheath for radiographic determination of the relations of the cyst to the surrounding structures.

Biopsy of prostate gland. Biopsy of the prostate gland is performed in a manner similar to that already described for other localities. The punch is introduced through the perineum at a point about 1 centimeter lateral to the midline and the point of the punch is thrust forward into the selected area of the prostate, being guided by a palpating finger in the rectum.

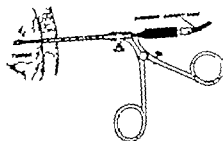


Fig. 4. The electrode has been introduced through the sheath and is shown coagulating the opening in the tumor and the needle track.



Fig. 5 Case 82. E. L. Punch biopsy of breast tumor. Paraffin section. Infiltrating duct carcinoma.

Preparation of the specimen The piece of tissue obtained by the punch measures 5 by 5 by 2.5 millimeters and is large enough for an immediate smear frozen section or paraffin preparation. If the tissue is soft and cellular a smear may be made by crushing a small portion between two glass slides or by touching the specimen to several areas on a glass slide previously warmed over a flame. This will cause the specimen to adhere and thus detach some cells. These smears when stained by hematoxylin and eosin afford a finished preparation in 6 to 8 minutes.

The solid piece of tissue is placed in 10 per cent formalin and carried through the regular stages of fixation to be made into permanent paraffin block preparations. Four or five sections are usually cut from these blocks and mounted on a single slide. The finished result is a section of an actual piece of undistorted tissue from which a pathological diagnosis can usually be made. If greater haste is required, a quick paraffin section can be prepared in about 3 hours.

In this series of 100 tumors the biopsy specimens, as a general rule, were prepared as immediate smears and paraffin sections. The advantage of the former is that a diagnosis may possibly be made in a few minutes; the disadvantage is that because the characteristic structure is lost the diagnosis of a smear must rest on the abnormal morphology of some clumps of cells. The information gained is, therefore, often limited. The paraffin sections require longer to prepare but afford an excellent final result which, except for size, is similar to the sections ordinarily encountered by pathologists. Because they present a section of undistorted tissue their diagnosis does not demand the special experience required in the interpretation of smears. It naturally follows



Fig. 6 Case 100. E. B. Punch biopsy of tumor of scapula. Paraffin section. Large spindle and giant cell osteogenic sarcoma.

also that more information can be gained from the section than from the smear. For instance, one can determine not only whether or not a certain tumor is malignant, but often also its pathological classification and whether or not it is likely to prove radiosensitive.

CLINICAL APPLICATIONS

The biopsy punch has been employed at the Memorial Hospital in the diagnosis of tumors located within the body beneath normal overlying structures. It has not been used within the abdominal or thoracic cavity and only with caution in the neighborhood of important vessels and nerves. By this means it has been possible

- 1 To diagnose obscure tumors entirely lacking pathognomonic features which would have indicated their character.

- 2 To obtain definite knowledge of the pathological type of a disputed tumor and thus decide



Fig. 7
of thigh.
malign

upon the treatment (whether surgery, irradiation, or both)

3. To secure adequate histological proof of the nature of inoperable tumors destined to be treated by irradiation

4. To determine the ultimate effect of irradiation on tumors apparently successfully treated by that method several years previously

CLINICAL RESULTS

In a series of 100 punch biopsies done during the past 2 years at Memorial Hospital, there have been no accidents. Hemorrhage or infection have never occurred. Trauma is negligible since only a single puncture is made. The danger of local or general dissemination is probably slight; the coagulation of the puncture wound in the tumor and of the needle track attempts to eliminate this danger.

This series of 100 punch biopsies included tumors of breast, prostate, bone, cervical, axillary and inguinal nodes as well as subsurface tumors generally. The consistence and structure ranged from that of a simple cyst to that of an osteogenic sarcoma of bone. In every case tissue was obtained on the first attempt at biopsy. From the specimens obtained from these 100 tumors, 93 positive diagnoses were made (93 per cent). In 7 instances the material obtained by the punch failed to reveal any evidence of neoplastic disease although there was evidence in 4 of these cases to warrant that clinical diagnosis. In the 3 remaining cases (33, 35 and 37) there was no palpable tumor present and the only evidence of abnormality was an increased consistence of the breast. These cases are here listed as failures although it is doubtful that any malignant tumor is present. Thirty-six of these 100 tumors have been removed surgically and the whole specimens submitted to pathological study. In 34 of these cases the diagnosis made after examination of the whole specimen agreed with that made from the specimen obtained with the punch. The 2 exceptions were Cases 9 and 32. In both these instances the punch had not been introduced into the tumor and only normal tissue had been obtained. In no case on the other hand, has a positive diagnosis of malignancy made from the biopsy punch material been contradicted by the diagnosis made after examination of the whole excised tumor.

Seventeen of these tumors had been treated by heavy doses of interstitial irradiation from 1 to 7 years previous to punch biopsy, so that they were reduced to hard, shrunken, and, in some instances, calcified nodules of scar tissue. In 12 instances, strands of carcinoma cells were demonstrated

among the dense whorls of radiation fibrosis. In the 5 remaining cases, no cancer cells could be demonstrated. In these latter 5 cases the cancer presumably has been destroyed. In each, the persistent tumor was reduced to a small nodule and there was no clinical evidence of activity. They are therefore listed among the successful biopsies since it is a fairly reasonable assumption that the cancer has been eradicated.

ADVANTAGES

Among the advantages of this instrument and technique are these:

1. By means of this instrument and technique of biopsy, early diagnosis may be obtained at a time when pathognomonic clinical features are not yet developed.

2. It is a minor procedure done under local anesthesia in the physician's office at the time of the first examination. Most patients who refuse the suggestion of an operative biopsy consent readily to a punch biopsy.

3. A solid piece of unchanged tissue is obtained.

4. The piece of tissue is large enough to exhibit the characteristic structure of the portion of the tumor from which it was removed, and to furnish material for immediate smear, frozen section or paraffin preparation.

5. The tumor is punctured but once although additional pieces of tissue may be obtained through the original puncture wound, if desired.

6. The cutting action is positive; the tissue is cleanly cut away; the specimen is not crushed or coagulated. The normal structural relations, in most instances, are preserved.

7. It is successful in a wide variety of material, whether fluid, semi-fluid, caseous, soft cellular, densely fibrous or osteoid in character (bone tumors which have eroded the cortex).

8. By means of the punch a specimen may easily be obtained from the wall of a cyst and by means of a syringe fitted to the sheath its contents may be evacuated or opaque media injected.

9. The opening in the tumor and the needle track are coagulated before withdrawal of the punch, thus rendering less likely the dissemination of the disease.

10. The punch in 100 cases has never failed to obtain a specimen from any tissue into which it has been introduced. Successful diagnoses were made from material obtained in 93 percent of cases.

SUMMARY

A new technique and biopsy punch are described and illustrated. By means of this punch

and technique an actual undistorted piece of a suspected tumor is obtained through a small puncture wound and removed through a sheath without contaminating the intervening normal tissues. The opening in the tumor and the needle track are coagulated by an insulated electrode connected to a source of high frequency (surgical diathermy) current as the instrument is withdrawn.

The use of the punch and the methods of preparing the specimen are described. Biopsies by this method have been performed on 100 patients at the Memorial Hospital, this group including a wide variety of tumors and many of dense fibrous structure.

An actual piece of tissue was obtained in each case on the first attempt. From these specimens paraffin sections and smears were prepared. Successful diagnoses were made in 93 instances (93 per cent). Thirty-six of these tumors were later removed surgically and the punch biopsy diagnoses were checked by comparison with the patho-

logical diagnosis made after examination of the whole specimen. In all but 2 cases the final pathological diagnosis agreed with the diagnosis made from the punch biopsy specimen. The exceptions were cases in which the punch had not been introduced into the tumor and only normal tissue had been obtained. The accuracy of diagnosis in these checked cases was thus about 94 per cent.

The action of the instrument is safe, simple and positive. In the whole series there has not been an instance of fungation, infection or hemorrhage. The danger of local or general dissemination appears to be slight, trauma is negligible, the coagulation of the puncture wound in the tumor and of the needle track is an attempt to eliminate this danger.

This article was awarded Certificate of Honor, Class II by the American Medical Association at the Philadelphia Session, June, 1931.

The author gratefully acknowledges the co-operation of M. Reinhold Wampler of the American Cystoscope Makers, Inc., whose technical knowledge and mechanical skill were of material assistance in developing this instrument.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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APRIL, 1933

GASTRIC ULCER IN ITS RELATION TO CARCINOMA OF THE STOMACH

NO more illuminating study of cancer of the stomach has been published in recent years than the paper by Alvarez dealing with 41 physicians who were treated for it at the Mayo Clinic. Physicians are supposedly aware of the devious ways of this treacherous disease, are supposedly on the alert for its recognition, are supposedly convinced that in the battle against it surgical treatment and prompt surgical treatment is the only hope of salvation. But what did this group of physicians do? Did they promptly suspect cancer when they developed symptoms of gastric discomfort, of prolonged and progressive digestive disturbance, of actual obstruction? Did they promptly submit to radiological study? Did they promptly demand surgical exploration? The great majority of them did none of these things. The great majority of these men and women who should have known better either ignored their symptoms entirely or else permitted themselves to be treated for indefinite periods of time by medical measures apparently without

suspecting that they had set their feet on the way that leads inexorably to death. Small wonder in the face of this record that laymen procrastinate as they do when the shepherd strays: one cannot expect the sheep not to wander from the path.

Particularly noteworthy in this study just as he is noteworthy in any similar study is one special type of patient. He tells a long story of previous indigestion which has perhaps responded well in the past to medical treatment but which now remains obdurate to it. Or he suddenly exhibits an exacerbation of symptoms or a change in symptoms. That was the sort of history that was given by 21 of the 41 patients Alvarez studied, and it is the sort of history that immediately introduces either the possibility of a previous ulcer or the absolute certainty of one. The relation of gastric ulcer to gastric carcinoma is a question upon which authorities of equal eminence hold opinions that are diametrically opposite, but Alvarez is perfectly correct when he says that the man who can ignore such facts as these has a mind that is impervious to evidence of any kind.

The origin of cancer is an academic consideration as is the question of the exact percentage of gastric ulcers which turn into cancer or the number of cases of cancer which are superimposed upon ulcers. The microscopic radiological, and clinical criteria which must be invoked to solve the problem fade into insignificance beside the fact that some cancers apparently develop from ulcers, that some ulcers apparently develop into cancers, and that some supposed ulcers are undoubtedly cancers from their inception. The crux of the

problem therefore is whether or not the prolonged medical treatment of gastric ulcers is safe. Such treatment as Alvarez points out is always based upon the fallacious assumption that the differentiation of gastric ulceration from gastric malignancy is possible by clinical and radiological methods whereas repeated studies have shown that this is not only not possible but also that it is not even approximately accurate.

A guess which in some 25 or 30 per cent of all cases is the best that the most experienced clinician and radiologist can offer is a poor peg as Lord Moynihan says upon which to hang a man's life. And make no mistake it is a life that is in the balance. The medical treatment of gastric ulcer may be relatively safe even if it does not relieve the patient but the medical treatment of gastric cancer is equivalent to manslaughter or suicide from which ever point of view you happen to be regarding it. Gastric ulcer and gastric malignancy must be distinguished positively not probably before the medical treatment of the supposed ulcer is undertaken. The surgeon must be absolutely certain that he is dealing with an ulcer before he withholds surgery regardless of how unlikely or how uncommon he personally feels the transition to malignancy to be.

The only safe rule is to regard as cancer any indigestion, with or without other symptoms which appears after middle life in a previously well person, to regard as cancer any acute digestive disturbances in this period which are superimposed upon chronic digestive disturbances and which do not respond promptly to routine measures, to regard as cancer or as highly suspicious of it vague general symptoms even though associated gastric disturbances are lacking to continue to regard as cancer any of these clinical syndromes until it is proved beyond a shadow of doubt that

it is not cancer and to resort without delay to exploratory laparotomy if the diagnosis can not be made otherwise. The suspicion that cancer exists is the one thing that matters in malignant disease the certainty of diagnosis is frequently also the certainty of death. 'The salvation of human life says Lord Moynihan is a greater thing than the establishment of a convincing, irrefutable clinical diagnosis' and Arthur Curtis remarks in another connection that 'it is better to have a less accurate diagnosis and a more favorable prognosis. Operation on suspicion is justified in this disease in which one can scarcely tell what a day will bring forth or at what moment an operable lesion may become an inoperable one. Accurate diagnosis is a desideratum but in the absence of incontrovertible negative findings or in the presence of doubtful positive findings the surgeon is entirely justified in exploring without hesitation every person in middle life or before middle life who exhibits a dyspepsia which does not respond promptly and permanently to established methods of treatment. Cancerous indigestion has no hallmarks while it is still amenable to cure to distinguish it from indigestion of other origins. A properly performed exploratory incision was never responsible for a fatality and the multitudes cannot be counted whom it has saved from death.' URBAN MAES.

THE TRAINING OF THE SURGICAL NURSE

THE prime objective of the nursing profession as well as that of the medical profession and hospitals is the prevention and cure of disease. The duty of the hospital to train nurses is secondary to their obligation to give the best care to sick patients. The time was when the best interests of surgically sick patients were most efficiently guarded by having every pupil nurse receive

some practical training in operating room procedure, including the very particular and technical work of 'handling instruments' at operations. This covered the period of anti septic surgery and the early days of aseptic surgery when the facilities of the modern hospital had not yet been made accessible to all communities by the modern road and ambulance. In those days, fortunately past any nurse might have been called upon to prepare for a major operation in any home. Today there is rarely a call for such service. The passing of this need has not seen the nurse training schools alive to the change.

The nursing schools are putting each pupil through the mill of operating room service when today the best interests of the patient can be advanced very materially if the patient be not made the means of practice and training. No medical school trains its students in technical surgery. These students receive their technical surgical training in graduate courses as internes and as assistants to trained surgeons. The surgical clinic of today that is not associated with a training school or the one that uses graduate operating room nurses, all other things being equal is giving the best service to the patient and enabling the doctor to do his best by his patient.

The qualifications of a good surgical nurse assistant are exact rigid and specific. A few of these are physical and nervous stability evenness of temper control of emotions ability to think and to act quickly in an emergency unusual capacity for the details and minutiae of preparation for an operation dependability which is the result of uniformity of procedure and yet an adaptability to the infinite variations that make each similar operation different from every other one. She must have that peculiar quality of intuition that permits the *rare* assistant to be just a step ahead of the operator to anticipate his needs

before they are expressed. In a class of sixty girls, evenly selected girls not over 10 per cent show any large proportion of these qualifications. Technical work requires specialization.

The Class A hospital of today backed by the American College of Surgeons and the American Medical Association is demanding the highest qualifications of those surgeons permitted the privilege of utilizing its operating rooms. Such a hospital states that it owes a duty to the public at large and so must insure the public that only an efficiently trained surgeon may use its facilities. This being true the same hospital should be allowed to furnish equally efficient technically trained nurses. This these very excellent hospitals do not do for the rules governing trained registered nurses, require that every nurse no matter what her personal characteristics be put through a six eight or ten weeks operating room course and made to "assist" with at least twenty five operations. The medical college does not try to make every student a surgeon. They know that the surgeon must be born as well as made. The surgeon selects his specialty because of a love for surgery. The December 1932 examinations for nurse registration in Ohio specifically asked "For how many operations have you been the sterile nurse? Majors? Minors? The most perfectly adapted nurse for this technical work cannot hope by any stretch of the imagination to acquire proficiency in the time allotted. For a large proportion it represents time lost and lost at the expense of the hospital the doctor the nurse teacher and above all the patient.

How can this situation be corrected? Just two adjustments are necessary. First, change the regulations to make it unnecessary for the pupil nurse to 'handle instruments for operations. Second require that the "sterile" nurse

who "handles" the instruments at the operation be a graduate nurse. She may have an undergraduate 'sterile' assistant.

What will be accomplished by these changes? Many nurses will not be given a responsibility for which they are unfitted. Numberless hours of futile effort will be saved on the part of nurse supervisors and doctors. The placing of the student as "sterile" assistant to the 'sterile' graduate operating nurse will give the intelligent pupil all she needs of knowledge of surgical asepsis and technique and permit her to obtain this training at an early period in the school schedule to the benefit of her subsequent training. (Many advanced thinkers on the subject of nurse training feel the operating room experience should come early in the three years course.) Valuable time will be saved during each operation and while a few minutes more or less do not appreciably change the result of the average operation, these minutes saved may

mean a life saved in the bad risk and emergency case. It means the assurance of a more perfect technique to the end that complications may be eliminated. It means the surgeon's attention can be centered on the actual operation technique so that he will not have to divert his attention from the field of operation to direct a "green" nurse assistant. It means less wear and tear on the surgeon which in turn means better service to the patient.

Team work has become essential to good surgical work. The anesthetist, assistant nurses, and surgeon must work together. One new "cog wheel" in the engine or one 'green' horse in the team slows up the work and makes it less efficient. Who suffers? The patient. It therefore behooves the medical profession, hospitals and the nurses themselves to see that the rules regulating these affairs are arranged to give the patient the best service possible. DUDLEY W. PALMER

MEMOIRS

GEORGE DAVID STEWART

DECEMBER 28 1862—MARCH 9, 1933

Thou Power Supreme, whose mighty scheme
These woes of mine fulfill,
Here firm, I rest—they must be best
Because they are Thy will.
Robert Burns.

THE officers regents and administrators of the American College of Surgeons mourn the loss of a distinguished founder and a past president George David Stewart

He was a great man a great American a great surgeon and one of the most beloved members of the profession. Among his outstanding qualities were his strong character his human heart his love for his fellow man his unfailing friendship and loyalty his honesty of thought, his fearlessness, his tireless energy his fund of humor and his overpowering personality.

We shall miss his inspiring presence at the meetings of the College and of the Clinical Congress, his happy companionship and his courageous support of those principles which were on the side of right.

On several occasions I heard from his lips the following words from Havelock Ellis: "The present is in every age merely the point at which the past and future meet. There is never a moment when the new dawn is not somewhere breaking over the earth and never a moment when the sunset ceases to die. We should greet the new dawn serenely not hastening toward it with undue speed nor yet leaving without regret the dying light that was once dawn."

His belief that "civilization must move our profession must move both are dynamic, not static and change is life" was best exemplified by his interest in the younger men of the profession to whom his very life was a constant inspiration and in whose accomplishments lay his greatest pride. It is only fitting therefore to append some notes on phases of Doctor Stewart's life by one of his "boys" who was associated with him for twenty five years.

FRANKLIN H. MARTIN M.D.



To David Stewart

GEORGE DAVID STEWART was born in Upper Malagash, Cumberland County Nova Scotia, on the shores of Northumberland Straits, where the climate is ten months of winter and two months of late fall, a lovely place with magnificent views in the summer—when there is a summer.

The teachers in the country school which he attended were not educated, but one, who influenced his life in his tenderest years, knew how to sing Methodist hymns and how to read and write. His early education was fatuous and depended largely on the library of his grandfather—a library which consisted of the Bible Bunyan's *Pilgrim's Progress* Jeremy Taylor's *Holy Living and Dying* Boston's *Fourfold State* Baxter's *Call to the Unconverted* and *Saints Everlasting Rest* and the poems and songs of Robert Burns. The Bible he was compelled to read Robert Burns he read from choice. Hence he had a fine collection of the latter's poems tucked away in his brain for ready reference.

At the age of fourteen he ran away to sea. The schooner on which he shipped was a slow one and sailed steadily for six weeks. This sufficed to prove that seafaring was not his metier. Then by luck, on his return home a very good teacher came along and one year's instruction under that teacher enabled him to teach himself. He taught a country school later graduated from the Normal School Truro and St. Francis Xavier College Antigonish Nova Scotia and served as the principal of a village high school. He just escaped being a preacher.

Doctor Stewart graduated from Bellevue Hospital Medical College in 1889. After his internship of one year at Bellevue Hospital he was appointed preceptor in demonstrative anatomy and later professor of anatomy. It was his good fortune to serve at Bellevue under Joseph D. Bryant, Frederic S. Dennis and the elder Thayer. In 1914 he succeeded Dr. Bryant as professor of surgery, University and Bellevue Hospital Medical College, and it was here that he accomplished his greatest work. His teaching clinic was unexcelled.

As a lecturer he had few equals. At the conclusion of each lecture he insisted that the notes should be destroyed. In this way, by constant re-preparation he kept his mind virile. In recognition of his achievements his friend the late George F. Baker gave a million dollars to found the George David Stewart Endowment for Surgery.

He disliked writing articles on surgery. To use his words "There is more loose motion in the contributions to medical science particularly surgery than in anything else except in a wooden doll or a marionette."

To estimate Doctor Stewart from his published literary contributions to surgery would be unfair and unjust. His impress on American surgery can be properly evaluated only by those who have enjoyed his care and his skill, and those thousands of young men who have felt the influence of his personality and of his character as a teacher and as a man.

ARTHUR M. WRIGHT M.D.

EARLY AMERICAN MEDICAL SCHOOLS

THE EARLY HISTORY OF THE FIRST MEDICAL SCHOOL IN THE COLONIES—THE UNIVERSITY OF PENNSYLVANIA

I S RAYDEN B.S. M.D. PHILADELPHIA

WHEN William Penn founded his colony in Pennsylvania in 1682 he undoubtedly considered the medical needs of the colony for he brought with him on the *Illcove* Thomas Wynne Griffith Owen and other men trained for the medical profession arrived during the autumn and winter of the same year. In 1711 John Kearsley arrived and in 1717 Thomas Graeme. These men and others who came during that period acted as the teachers of their art and as the preceptors of the rising generation. Their successors were for the most part natives of this country. Of these, Thomas Cadwallader William Shippen Sr. Thomas Bond Phineas Bond John Redman, John Kearsley Jr. Lloyd Zachary Cadwallader Evans and John Bard played important parts in the early medical activities of the colony.

The older men fired the imagination of their apprentices with the advantages to be obtained by subsequent training at Edinburgh London, Paris, or Leyden, and most of the younger men added to their preparation by studying at one of these places.

In the settling of new countries, the first care of the planters must be to provide and secure the necessities of life. Agriculture and mechanical arts, were of the most importance the culture of the minds by the finer arts and sciences, was necessarily postponed to times of more wealth and leisure. Thus it was that on the 24th of August, 1749 Benjamin Franklin announced the prospectus of his scheme for the higher education of the youth of the colony and from it developed the University of later years.

Two years later Thomas Bond sought Franklin's assistance in the building of a general hospital for the sick and injured. On the 23rd of January 1751 "Sundry Inhabitants of the Province of Pennsylvania had petitioned the Assembly for the establishment of a permanent, public hospital. While Franklin and Bond were busy arranging for the beginning of the Academy

to train the mind, they also found time to plan the institution which was to provide the means for the founding of the Pennsylvania Hospital. The hospital was first located in a house on Market Street near Sixth, but on the 28th of May 1755 the corner stone of what is now known as the East Wing was laid on the present site. Franklin's inscription on the corner stone was as follows:

IN THE YEAR OF CHRIST
MDCCLV
GEORGE THE SECOND HAPPILY REIGNING
(FOR HE BOUGHT THE HAPPINESS OF HIS PEOPLE)
PHILADELPHIA FLOURISHING
(FOR ITS INHABITANTS WERE FOREVER SPIRITED)
THIS BUILDING
BY THE BOUNTY OF THE GOVERNMENT
AND OF MANY PRIVATE PERSONS
WAS DEVOTELY FOUNDED
FOR THE RELIEF OF THE SICK AND MISERABLE.
MAY THE GOD OF MERCIES
BLESS THE UNDERTAKING.

It was thus that the Pennsylvania Hospital and University were born of the same parentage and most of the professors in the earlier years of the Medical School were on the staff of the Hospital.

Thomas Cadwallader who had studied anatomy in London under the celebrated Cheselden, settled in Philadelphia and gave demonstrations to the physicians of the locality. Since Cadwallader established himself in Philadelphia before 1751 he was probably the first to give anatomical lectures in America. There was as yet no School of Medicine and sixteen years were to elapse before the College and Academy could boast of one.

John Morgan who had pursued his medical studies under John Redman, went to Europe in 1760. For two years he attended the lectures at the University of Edinburgh, from which institution he received his degree in 1763. Before going to Edinburgh he had attended William Hunter's lectures in London, and subsequent to his study in Edinburgh he went to Paris, Holland, and Italy.

1765 -
A course of Lectures -
on the Materia Medica & Practice
of Physic, as managed by Mr J. M.
to be given at his house
in the 4th Ward near the 4th
at 5 o'clock on Wednesdays
by John Morgan M.D.
Prof. of Physic in the



Front of first admission card to John Morgan's lectures.
 A playing card was used.

While in London in November 1764 he wrote to Dr Cullen in Edinburgh "My scheme of instituting lectures you will hereafter know more of. It is not prudent to broach designs prematurely, and mine are not yet fully ripe for execution. He had discussed his plans with the younger Shippen while they were together in Edinburgh. Shippen had returned to the Province in May 1762 and on November 25 of that year he announced in the *Pennsylvania Gazette*. Dr Shippen's Anatomical Lectures will begin to-morrow evening at six o'clock, at his father's house in Fourth Street. Tickets for the course to be had of the Doctor at five Pistoles each and any gentlemen who incline to see the subject prepared for the lectures and learn the art of Dissecting Injections etc. are to pay five Pistoles more. In later years Wistar who became one of the great anatomists remarked "Such was the origin of our medical school." These lectures indeed proved to be the beginning of the broader plan of Morgan which was to found the Medical School of the College and Academy of Philadelphia.

John Fothergill of London had always evinced an interest in the medical affairs of the Province. The Pennsylvania Hospital having been erected he took it for granted that students would resort to it, and well he knew the difficulties that would beset them in the acquisition of a knowledge of anatomy. To remedy this defect Fothergill employed Rumsdyck to execute crayon paintings of the human anatomy.

Shortly after Shippen returned he advised the managers of the Hospital that Fothergill had sent seven cases of anatomical drawings. In a letter to James Pemberton, Fothergill had written and that the means of procuring subjects with you are not easy some pretty accurate anatomical drawings about half as big as the life,

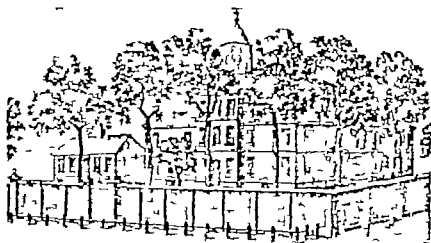


Department of medicine East side of Fifth street between Library and Walnut Streets, 1765 to 1802 Building known as Surgeons' Hall

have fallen into my hands which I propose to send to your hospital. I have recommended it to Dr Shippen to give a course of Anatomical Lectures. He is well qualified for the subject and will soon be followed by an able assistant, Dr Morgan both of whom, I apprehend will not only be useful to the Province in their employments but if suitably countenanced by the Legislature will be able to erect a School of Physic amongst you, that will draw students from various parts of America and the West Indies.

Morgan arrived in Philadelphia early in 1765 and at a special meeting of the Trustees of the College and Academy called for on the 3rd of May, 1765 which was attended by Thomas and Phineas Bond Cadwallader and Redman Morgan presented his plan. He brought with him a letter from the Proprietory Thomas Penn which was indeed laudatory. Dr Morgan has laid before me a proposal for introducing new professorships in the Academy. We are acquainted with what is proposed to be taught and desire that he may be well received and what he has to offer be taken with all becoming Respect and Expedition into your most serious Consideration.

After considering the matter The Trustees entertaining a high sense of Dr Morgan's Abilities and the Honors paid to him by different Learned Bodies and Societies in Europe they unanimously appointed him Professor of the Theory and Practice of Physick in this College. On May 30 and 31 of the same year Morgan gave his inaugural oration "A Discourse upon the



The first wing of the Pennsylvania hospital.

Institution of Medical Schools in America. Morgan was the first physician in Philadelphia to restrict himself to simply prescribing for the sick.

Can any man the least acquainted with the nature of that arduous task, once imagine it possible for me to acquit myself in that station in an honorable or useful manner and yet be engaged in a continued round of practice in surgery and pharmacy as well as physic? On September 23 of the same year Shippen was appointed to the professorship of anatomy and surgery and on September 26 the following announcement appeared in the *Pennsylvania Gazette* "As the necessity of cultivating medical knowledge in America is allowed by all it is with pleasure we inform the public that a Course of Lectures on two of the most important branches of that useful science viz., Anatomy and *Materia Medica* will be delivered this winter in Philadelphia. In order to render these courses the more extensively useful, we intend to introduce into them as much of the Theory and Practice of Physic, of Pharmacy Chemistry and Surgery as can be conveniently admitted.

From all this, together with an attendance on the practice of the physicians and surgeons of the Pennsylvania Hospital, the students will be able to prosecute their studies with such advantage as will qualify them to practice hereafter with more satisfaction to themselves and benefit to the community." It was signed by Morgan and Shippen.

The first class of students was enrolled in the fall of 1765 and of these ten were graduated with the Degree of Bachelor of Physic in 1768 "the birthday of medical honors in America." The question as to whether the College of Philadelphia or

King's College in New York has the honor of priority in the awarding of medical degrees in this country may now be answered. The degrees of Bachelor of Medicine conferred June 21 1768, by the College of Philadelphia, were the first medical degrees conferred by an institution in the colonies. King's College conferred the same degree for the first time in 1769 and the degree of Doctor of Medicine in 1770. From this it appears that the claim of priority in conferring degrees in medicine must be awarded to the College of Philadelphia while the precedence in conferring the Doctorate must be given to New York. Morgan and Shippen constituted the major Faculty until January 1768 when Adam Kuhn was made professor of botany and *materia medica*. Kuhn, also, had received a part of his medical training in Edinburgh.

Thus the first medical school in North America was in reality an offspring of the most brilliant school in Europe at that time. The professors had unavoidably acquired an affection and preference for the Scottish school a type of instruction, and for many years the major portion of its professorial faculty received some of their training within the walls of Edinburgh. The University has continued to feel a very close connection to its patron over the seas, and the iron grill over the present entrance contains the thistle. The first medical trustees of the College were the senior Shippen, Thomas Bond, Thomas Cadwallader, Phineas Bond and John Redman.

A very close relationship existed between the college and the Pennsylvania Hospital, and Thomas Bond interested alike in both, would welcome the pupils and graduates of the medical



The University of Pennsylvania, 1806-1839, showing the addition to the left, which housed part of the medical school. The main building was originally built to be Washington's house.

school attending his clinics in the latter and this interest was shared by his colleagues. In this way, the hospital became the first clinical school of the College.

Before another commencement occurred a young physician Benjamin Rush who had also earned his degree at Edinburgh was coming home to become the professor of chemistry in the new school. The average age of the four professors was under 30 years.

The disordered condition of society attendant upon the Revolution disturbed the quiet flow of scientific pursuits. Several of the professors of the Medical School went into the army. Morgan and Shippen successively acted as medical director general and Rush as medical director of the middle department, the latter being one of those who signed the Declaration of Independence.

In these troublesome times of new freedom the Charter of the College of Philadelphia was revoked by an act of the Legislature in November 1779. This was the result of a feeling that the institution, being of colonial origin and patronage, needed thorough reorganization in order to place it on a basis harmonizing with the régime of Independence. The property of the College was transferred to a new institution.

The institution which took the place of the College of Philadelphia was called the University of the State of Pennsylvania. The trustees of the new school at once directed attention to the medical department. They requested the several Medical Professors in the mean time to proceed in their lectures as before. Dr Shippen was the only one of the professors who at once accepted the position he had held in the Faculty of the College. Great difficulty was encountered in forming a faculty and in October 1781, Thomas Bond was requested to unite Lectures on the

Theory and Practice of Physic with his course of Clinical Lectures until such time as a professor of that branch of medicine be appointed and undertake the business. This state of irregularity existed until November, 1783 when the former status of the professors was accepted by them.

Friends of the former College were successful in having the charter and property of the college restored in 1789 the new institution however retaining its position as a University, with its endowment from confiscated estates.

There existed then two medical schools with a somewhat interlocking faculty. Shippen taught in both schools, Kuhn only in the University, while Wistar took the chair of Chemistry at the College. James Hutchinson became professor of chemistry in the University and Rush became professor of theory and practice in the College. Morgan died at this time. The College decided to abolish the degree of Bachelor of Medicine and to confer only the Doctorate.

The field for two establishments proved to be too restricted, and after party spirit had subsided and factional strife lulled to rest it was realized that in union there would be additional strength. An amicable adjustment was brought about in September, 1791. It was agreed that the name of the united school was to be "The University of Pennsylvania." In the inaugural lecture delivered by Benjamin Rush in November 1791, he said "I should do violence to my feeling should I proceed to the subjects of the ensuing course of lectures, without first congratulating you upon the union of the two Medical Schools of Philadelphia, under a Charter founded upon the most liberal concessions by the gentlemen who projected it. By means of this event the ancient harmony of the different professors of medicine



The University of Pennsylvania, 1829 to 1873. On the left is Medical Hall.

will be restored and their united efforts will be devoted, with accumulated force towards the advancement of our Science.

The new faculty consisted of the professors of both schools. The announcement gave the professors and their subjects as follows:

Anatomy, Surgery and Midwifery	William Shippen, M.D. Casper Wistar, M.D. Adjunct.
Theory and Practice of Medicine	Adam Kuhn, M.D.
Institutes of Medicine and Clinical Medicine	Benjamin Rush, M.D. James Hutchinson, M.D.
Chemistry	
Materia Medica and Pharmacy	Samuel P. Griffiths, M.D.
Botany and Natural History	Benj. Smith Barton, M.D.

In 1805 a change was deemed to be expedient in the chair which had been held so long and honorably by Shippen. Surgery had remained in association with anatomy and obstetrics. Philip Syng Physick, who since 1794 had been one of the surgeons to the Pennsylvania Hospital, was elected professor of surgery. At this time the mother school in Edinburgh still combined anatomy and surgery in one chair. He filled the chair for 14 years, at which time he became professor of anatomy. One of his last major operations was one on Chief Justice Marshall for the removal of a stone in the bladder. Physick truly deserves the appellation so frequently applied to him "Father of American Surgery."

Shippen died in 1808. He had been a great teacher and had played a very important rôle in the early history of Philadelphia medicine. He was succeeded by Casper Wistar who at first taught both anatomy and midwifery but in 1810 the combined chair of anatomy and obstetrics was

divided. Thomas Chalkley James was elected professor of midwifery but it was not until 1813 that attendance upon his lectures was made obligatory for graduation. Wistar died in 1818. He was an ardent advocate of the use of models in teaching. His extensive group of models and specimens were presented to the University and were for years styled the Wistar Museum. It was greatly enlarged by two of Wistar's illustrious successors, Horner and Leidy. In 1819 the chair of surgery was awarded to William Gibson, who at the time was professor of surgery in the University of Maryland whose School of Medicine was founded by Pennsylvania's first medical graduate John Archer Dewees, who had been adjunct professor of obstetrics, succeeded James in 1834. He was the first authoritative writer on this subject in America and may truly be regarded as the "Father of American Obstetrics."

With the separation of the important chairs into individual units, the School of Medicine of the University had begun the second period of its development. Those who succeeded maintained the high standard already set for them. The names of Horner, Leidy and Penros, of Hare and Coxe of Agnew and John Ashhurst of George B. Wood, Horatio C. Wood, of the William Peppers, Stille and Osler of Mills and the Norrises of Hodge, Goodell and R. A. F. Penrose of Guiteras, Durhing and many others fill an important niche in the history of American Medicine in the nineteenth century.

Philadelphia maintained its reputation as the medical center of the country. The splendid clinical instruction which had been begun in the Pennsylvania Hospital in 1766 by Thomas Bood, in connection with the medical lectures at the College was expanded. The instruction was given at the bedside and in the clinical amphitheater.

Clinical opportunities were also afforded at the Philadelphia Almshouse (Blockley) now the Philadelphia General Hospital. It had gone into operation before the Pennsylvania Hospital, but not strictly as a hospital. In it was established the first obstetrical clinic for students, as early as 1770. For periods of time students were excluded but after 1805 every successive year found the prejudices which had operated so long, more and more removed. The Managers with each succeeding year were seized with an active desire to foster and promote any method which contributed to the hospital's usefulness as a teaching institution.

In 1873 William Pepper, Jr. had the foresight to realize the importance of having a hospital

which should be an integral part of the Medical School. Largely through his efforts the present hospital of the University of Pennsylvania was built, the first hospital controlled by and built for a school in America.

Shippen's lectures had been delivered for years in apartments built in the rear of his father's home on Fourth Street. The other lectures were first probably given in the old Academy Building. The first building especially built for the use of the Medical Professors was situated on Fifth Street and was called Surgeon's Hall.

In 1802 the Medical School was partly moved to a former state building built for the president on Ninth Street between Chestnut and Market Streets and in 1806 an additional building was built on Ninth Street, and it was further enlarged in 1817. The school grew and accommodations rapidly became inadequate. The Trustees ordered that all buildings be removed and in 1829 built what for many years was known as Medical Hall. It was not until 1873 that the Medical School was moved to the present University site west of the Schuylkill River.

CORRESPONDENCE

FURTHER OBSERVATIONS ON THE ROLE OF BILE IN HIGH INTESTINAL OBSTRUCTION

To the Editor In a previous paper Benedict, Stewart and Cutner¹ reported the results of certain experiments on the rôle of bile in high intestinal obstruction. Although the results were not entirely conclusive they seemed to indicate that when obstruction of the intestine was so high that no bile could be reabsorbed, benefit might be derived from administration of bile below the obstruction.

In the course of further experiments on high intestinal obstruction in dogs, all bile was diverted from the intestinal tract by cholecystostomy and ligation of the common bile duct. Obstruction of the intestine was carried out a week later by completely severing the bowel just below the ampulla of Vater by inverting the proximal end and sewing a catheter into the distal end for use as an enterostomy. Through this catheter sufficient normal saline was administered twice a day to maintain water balance and normal blood chlorides. The cholecystostomy catheter was connected to a small rubber balloon and the bile withdrawn once a day.

One such animal survived for 38 days, at which time malnutrition probably was the most important factor in causing death. At no time was there any evidence of bile in the vomitus or stools, and autopsy revealed no accessory bile ducts. As this period of survival is longer than any heretofore reported in so high an intestinal obstruction the experiment would seem to disprove the theory that the presence of bile

either above or below an obstruction of the intestine is a factor of any significance in the length of survival of the animal. Death in high intestinal obstruction, when the water and chloride balance is maintained, is probably due largely to malnutrition.

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The author wishes to acknowledge with thanks the technical assistance of L. J. Thorne and D. G. Friend, students at the Harvard Medical School.

NEW MUSCLE-SPLITTING INCISION FOR RESECTION OF THE UPPER THORACIC SYMPATHETIC GANGLIA—A COR RECTION

In publishing this article in the March, 1933, issue, pages 651-657, a regrettable error was made which disarranged the order of the illustrations, certain of the plates appearing with incorrect legends. To correct the error the following changes should be noted: The plate appearing as Fig. 3 should be Fig. 1; Fig. 7 should be Fig. 5; Fig. 4 should be Fig. 3; Fig. 1 should be Fig. 4; Fig. 5 should be Fig. 7.—EDITOR.

JOHN B. MURPHY

Material is being collected for an authorized biography of Dr. John B. Murphy. If any reader of this JOURNAL has in his possession letters from Dr. Murphy, knowledge of facts concerning his life, or any other data, it would be appreciated if they were sent to the Editors. All material will be returned promptly and the source credited.

¹Benedict, E. B., Stewart, C. P. and Cutner, P. M. The rôle of bile in high intestinal obstruction. *Surg. Gynec. & Obst.* 1932, LV, 865.

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A DIFFERENTIAL DIAGNOSIS BETWEEN CERTAIN TYPES OF INFECTIOUS GANGRENE OF THE SKIN

WITH PARTICULAR REFERENCE TO HÆMOLYTIC STREPTOCOCCUS GANGRENE AND BACTERIAL SYNERGISTIC GANGRENE¹

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IN recent years there has been considerable interest in the problem of gangrene of the skin due to the invasion of micro-organisms. The literature in this field indicates that there has been great difficulty in the minds of some observers regarding the proper classification of these disorders. Many authors have reported late diagnosis late institution of treatment, extensive destruction of tissue long hospitalization and high mortality. This is due partly to the fact that these diseases (except gas gangrene) are relatively rare so that few observers have been able to report more than a single case. Confusion has further resulted from the fact that bacteriological studies have frequently been made so late in the course of the disease that it has been difficult to appraise the importance of the bacteria which have been found and frequently cultural methods have been used which were not suitable to reveal the significant organisms. It is with the purpose of clarifying this subject to some extent, that the present paper is written because the treatment of the various groups differs markedly and a delay in diagnosis results in a delay in instituting the proper treatment.

In infectious gangrene, bacteriological studies are essential if we are to learn anything about the pathogenesis of these infections and

improve our method of treatment. These studies should be made early in the course of the disease and cultures should be taken from various parts of the lesion particularly in the zone of advance. Anaerobic, as well as aerobic methods must be employed and culture media be used which is suitable for the growth of any organisms which may be present. It is obvious that this cannot be done in the great majority of cases, for many of them are seen either at home or in the office or in hospitals which are not fully equipped to make a complete bacteriological study. Furthermore the time required for the complete bacteriological analysis of any given case makes the study of little value as a basis of treatment for that particular case, particularly if the onset is sudden and the course is rapid. For all of these reasons it is essential that there should be a clinical differentiation by which any one seeing a case for the first time may recognize it at once and promptly institute the proper treatment. An attempt has been made, therefore in the following paragraphs to give a practical clinical differentiation between certain types of infectious gangrenous processes of the skin and subcutaneous tissues.

The most important division of these cases is into acute and chronic groups. In the former a diagnosis should be made within a few

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hours. In the latter it may be safely made within a few days.

ACUTE GANGRENE

Acute infectious gangrene may be divided into two subgroups of great importance. These differ in so many features that they ought not to be confused. The first is relatively common, namely gas gangrene. It was seen during the war by every army surgeon. This is so well known in this generation that it is hardly necessary to go into details with regard to it in this paper except to differentiate it from the other groups. Let us hope that the coming era of World Peace under the League of Nations and the Pact of Paris will make it a rare disease.

GAS GANGRENE

Gas gangrene has recently been excellently reviewed by Wan and by Davison and in individual cases have been reported by Linton, Shearer, Sarlin, Mies and Butler. Gas gangrene not infrequently develops in a deep punctured or lacerated wound which extends down into muscle and carries with it such foreign bodies as clothing, missiles, powder or street dirt. A large proportion of the cases of gas gangrene in civil practice follow compound fractures. Likewise occasional cases develop after operation following the amputation of gangrenous lower extremities in diabetics or arteriosclerotics. The possibility of its development in these cases should always be kept in mind because certain precautions may be taken to prevent its occurrence and its early recognition is essential for its successful treatment.

Symptomatology. The onset of the disease is usually associated with an abrupt rise in temperature and pulse rate. The pulse approaches 120 and the fever reaches 103 to 105 degrees. There is general malaise, marked prostration and restlessness as well as apprehension. There is usually an increase of pain in the wound. This may be masked if the wound has been painful from the first. An examination of the wound usually reveals swelling and edema with redness and acute tenderness. Gentle pressure on the margins of the wound usually produces a sanguino-purulent exudate in which gas bubbles may

be seen. A smear made from this exudate will almost invariably reveal large numbers of large gram positive bacilli. Gentle palpation of the tissues may reveal crepitus, but this may not be appreciated in the early stages. An X-ray film will frequently demonstrate gas in the tissues even before it can be felt. To an experienced observer with a keenly discriminating sense of smell there is a characteristic acid or 'mousy' odor.

When the infection has gained a foothold it spreads rapidly; the patient becomes very ill; fever remains high, the pulse rate increases, and crepitation around the wound is evident. This may advance appreciably from hour to hour. The spread of the disease is chiefly in the muscles. It may be confined to a single muscle from the wound margin up to its origin leaving the neighboring muscles free but usually it spreads up the neighboring groups as well to a varying extent from the wound. The skin at the wound margin becomes first red and then dusky. The redness and edema spread for a moderate distance around the wound but not extensively. Gradually the skin at the margin becomes dark and necrotic while the reddened area away from the margin takes on a yellowish brown or bronzed tint. Gangrene of the skin is generally limited to the margin of the wound and if the disease spreads extensively in the muscle the gangrene of the skin slowly advances but it does not appear in isolated patches away from the margin. In untreated cases gas gangrene is rapidly progressive and almost invariably ends fatally.

Etiology. The gas gangrene organisms are anaerobic bacteria which differ from one another in their cultural characteristics and in the specific toxins which they form. There are four different species which are pathogenic for man and although they rarely occur in pure culture in gangrenous processes, they are believed to be able, alone, to produce the general and local symptoms of gas gangrene and their specific toxins may cause death. However, they are frequently associated with other organisms and there may be a synergistic action enhancing the virulence of the pathogenic anaerobes or the associated organisms. The most common of the gas gangrene organ-

isms is *Bacillus aerogenes capsulatus* (Clostridium welchii). The others are *Bacillus oedematis* (Clostridium novyi), *Vibrio septique* (Clostridium oedematis maligni) and *Bacillus sordelli* (Clostridium oedematoides). The 3 last are more rarely found and if any one of these organisms is present the local signs vary somewhat from that already described in that there is more oedema and induration of the tissues and less gas formation.

Treatment. With the earliest signs of this disease a stained smear of the exudate should be made if possible. If the signs are unmistakable or if in doubtful cases large gram positive bacilli are numerous in the smear immediate operative interference is of the utmost importance. This procedure should not wait upon the cultural determination of the organisms. The wound should be completely excised and all foreign bodies and all necrotic tissue should be removed. Individual muscles should be explored and any inactive or devitalized muscle tissue should be removed. Anti gas gangrene serum should be used in large quantities. The serum which is now available is more potent and more concentrated than that which was formerly prepared and is effective against all of the known pathogenic gas gangrene organisms as well as tetanus. Concentrated monovalent and polyvalent sera are now available in "therapeutic doses." Depending on the severity and extent of the infection one or more "therapeutic doses" should be given intravenously as soon as the diagnosis is made and repeated every 8 hours until there is definite subsidence of local and general symptoms. If it is not possible to determine by culture what organisms are present, a polyvalent serum should be used but if an analysis of the flora of the wound has been made the specific antiserum should be administered in subsequent treatments.

There is a considerable difference in opinion as to whether amputation should be done in these cases. In certain regions of the body amputation is out of the question. However, even in a good many cases in which amputation may be done quickly and safely, if the disease is diagnosed soon after its develop-

ment, amputation is not indicated. Adequate opening of the wound and removal of dead tissue and the administration of serum is frequently effective and results in the subsidence of the process. Although it is likely that amputation has been done in the severer cases the statistics would seem to indicate that the mortality in amputated cases is not appreciably lower than in those in which that procedure is not employed.

HAEMOLYTIC STREPTOCOCCUS GANGRENE

Since the author's first report (60) in 1924 this infection has been described by Gage and by Jen as well as in briefer reports by Mainzer, Bate, Fallon and Bettmann and by the writer (61, 62). This disease may occur following a deep wound but is more likely to follow a much more trivial injury. Sometimes the injury is so light that it appears to be a spontaneous infection but in general there is a history of a superficial injury of the skin, a scratch, a cut, or a hypodermic injection. It generally occurs on the extremities but may involve any part of the body. In the earlier literature some of these cases have been described as phlegmonous or gangrenous erysipelas but there are striking differences between this disease and erysipelas which will be brought out later.

Symptomatology. The disease is characterized by the sudden onset of pain and swelling at the site of injury. The part becomes red, hot, swollen and heavy and while at first it may be very painful it later becomes numb or anæsthetic. The redness spreads rapidly during the first 2 days and may be very marked but the margins fade out into the normal skin and are not raised as in erysipelas. The temperature generally does not rise over 101 to 102 degrees except in rare instances when the illness is ushered in with a chill. Then the temperature may reach 103 to 104 degrees. On the other hand the pulse rate is rapid frequently approaching 120. Prostration is marked but instead of irritability, there is usually a marked lassitude on the part of the patient. He becomes indifferent to his surroundings and has a total lack of appreciation of the severity of his illness. On the second, third or fourth day the pathogno-

monic sign of the disease appears. *This should be watched for in any acute fulminating inflammation.* The sign is a dusky coloring of the skin appearing as a small purplish patch with irregular and ill defined margins. It may be some distance from the portal of entry. It has a bluish tinge which makes it distinct from the brilliant redness of the surrounding skin. At the same time a large blister or bulla may appear over this dusky area or some where else upon the red surface. These areas may extend very rapidly and changes in them may be seen from hour to hour. If proper treatment is not instituted at once other dusky patches may develop nearby and these areas may later fuse so as to form a large plaque of gangrenous skin. In untreated cases about the seventh, eighth, or ninth day if the patient survives, this necrotic skin becomes more sharply demarcated from the rest of the skin and a little later partial separation takes place along the edges. While the gangrene is developing the diffuse redness continues to spread. The patient becomes more and more prostrated fever ranges around 102 to 103 degrees, and metastatic foci may develop in the lungs in joints or elsewhere in the body. Frequent sites for these metastatic lesions are the subcutaneous tissues at pressure points or elsewhere. These metastases frequently form with very little redness but with a definite swelling and rapid formation of pus. In a few untreated cases the process comes to a standstill about the end of the second week, the slough separates and large plaques of necrotic subcutaneous fat may separate beneath a relatively normal skin. But most untreated cases go on to rapidly overwhelming toxæmia with septicæmia extensive metastases, and death. On the other hand if proper treatment is instituted early the whole process generally comes to an abrupt standstill and cases thought to be hopeless go on to rapid resolution and recovery. In the series of cases reported from China the mortality was 20 per cent but in the cases that I have seen in this country the mortality has approached 50 per cent. This higher mortality may indicate a difference in resistance to the hemolytic streptococcus between Chinese and Americans or it may be simply a question of late

recognition and late treatment. In the series which we reported from China the disease was so common that earlier recognition of it was possible. When an adequate operation was promptly performed, all of the cases which were not *in extremis* on admission responded satisfactorily to the treatment. With most of the cases which the writer has seen outside of the hospital diagnosis has been made late and the treatment has been delayed or inadequate. Under these circumstances the prognosis must be guarded for in such cases septicæmia is common and metastases frequent.

This disease is essentially a gangrene of the subcutaneous tissue with secondary gangrene of a part of the overlying skin resulting from a thrombosis of the skin arteries which pass through the aloughing subcutaneous fat. The subcutaneous gangrene may extend for a long distance beyond the area of skin gangrene. Through this extensive subcutaneous slough patent blood vessels may be found supplying the relatively normal skin.

Etiology. The hemolytic streptococcus is always found in these cases and in the great majority of cases it may be found in pure culture out in the advancing margin of the subcutaneous necrosis. Beyond the limit of subcutaneous necrosis there is a zone of redness and oedema which yields a sterile culture. This is in striking contrast to erysipelas for in the latter disease streptococci are most numerous in the advancing margin of redness and even beyond it in relatively normal skin. It must be assumed that in hemolytic streptococcus gangrene there is a toxin widely diffusible in the skin and subcutaneous tissues which gives rise to the rapidly spreading zone of redness. In the early stages the hemolytic streptococcus is also found in pure culture in the dusky areas of purplish discoloration and in the fluid of the blisters or bullæ. Later when the gangrene separates, other organisms may contaminate the field but usually do not spread widely. It is almost certain that these associated organisms play no part in the development of the disease and that it is, in fact, a pure hemolytic streptococcus infection. The rapidity of its development and the extensive necrosis which it causes, suggest that

the peculiar characteristics of the onset of the infection may be due to a hypersensitivity similar to the Shwartzman phenomenon (82) or the Arthus phenomenon (3). Certain cases seem to illustrate one type and other cases the other. The allergic etiology has not yet been proved beyond question and it is difficult to prove because according to Shwartzman streptococci can produce the secondary necrotizing effect but cannot produce the primary sensitizing effect of the phenomenon. The sensitizing phase may be and probably is non-specific. Another theory is that the organisms have some special predilection for the subcutaneous tissues or produce a ferment which acts quickly upon the subcutaneous connective tissue and fat. However efforts which have been made to demonstrate such ferments have proved unsuccessful. These tests have not been done, however with recently recovered strains of the organism.

Treatment. Surgery should not be delayed an hour after the diagnosis has been made. Contrary to the usual procedure either in erysipelas or in streptococcus cellulitis of the ordinary kind, longitudinal incision should be made at once through the gangrenous area and should extend in both directions just beyond the limits of the subcutaneous necrosis. Incision should be radical rather than conservative and long single incisions serve the purpose better than multiple small incisions in any given axis. The effect of these incisions is to relieve tension and at least partially to drain the involved area. This improves the blood supply and turns the flow of drainage away from the advancing margin. After operation hot water soaks or hot poultices should be applied until the cellulitis subsides. This usually requires 2 to 3 days. Then Dakin's fluid should be applied by means of tubes or frequently changed compresses to favor the rapid separation of the slough. Each day as much of the slough as can be removed without bleeding should be cut away. If incisions are early and adequate, the process will promptly subside and patients who look desperately ill when first seen, will show remarkable improvement and go on to complete recovery. But if operation is delayed for 24 hours after the pathognomonic signs appear,

the chances of recovery will be greatly diminished and the extent of subsequent skin necrosis will be greatly increased.

Differential diagnosis. Fulminating types of gangrene generally fall either into the gas gangrene group or into the hemolytic streptococcus gangrene group. They should not be confused for in the former the injury is almost always deep and the invasion is largely in the muscular layers with gas formation and crepitation both in the muscle and in the subcutaneous tissues while the skin is relatively free. In hemolytic streptococcus gangrene on the other hand the injury is usually superficial and the spread is almost always in the subcutaneous tissues with early involvement of the skin and without any crepitation. In gas gangrene the general symptoms are alarming and the local signs relatively mild. In hemolytic streptococcus gangrene the local signs are alarming and the general symptoms relatively mild. While both infections are primarily due to specific organisms infection may be rendered more severe by the association of other bacteria. However in the case of gas gangrene these organisms generally gain a foothold at the same time or before the organisms of the gas gangrene group whereas with hemolytic streptococcus gangrene the hemolytic streptococcus is alone responsible for the initiation of the infection and secondary contaminants only grow after there has been a break at the margin of the gangrenous portion of the skin. Stained smears of the exudate in gas gangrene show many gram positive rods while in streptococcus gangrene the exudate contains only gram positive diplococci.

Hemolytic streptococcus gangrene has been frequently confused with erysipelas which is likewise caused by a hemolytic streptococcus but certain features sharply distinguish them. In both diseases, the onset is sudden but in erysipelas the general symptoms overshadow the local there is usually a chill and a sudden rise of temperature to 103 to 105 degrees and the patient becomes apprehensive or irritable. In hemolytic streptococcus gangrene the local symptoms overshadow the general, a chill is rare, the temperature does not often go as high as 103 degrees. The patient is indifferent rather than apprehensive

and dull rather than irritable. In erysipelas the redness starts in a small area and spreads perceptibly but rather slowly with a red raised margin at least in a part of its periphery. There is very little swelling of the part and the tissues are soft. As it spreads, the center becomes pale again. In hemolytic streptococcus gangrene the onset is sudden, the affected part very rapidly becomes swollen and heavy, swelling and redness may spread up the whole extremity or widely over the body in 24 to 48 hours but the margin of redness is not raised and is generally indistinct as it fades off into normal skin. The center does not become pale but bullæ form and dusky areas appear on the third, fourth or fifth day and go on to frank gangrene. Lymphangitis and lymphadenitis are rare but phlebitis is fairly common. In erysipelas, organisms may be cultivated at and beyond the spreading margin (95) but not in the center while in hemolytic streptococcus gangrene there is a wide zone of redness in which cultures yield no growth but organisms are found in the blisters or bullæ and in the subcutaneous tissues out to the limit of the necrotic zone. Erysipelas may develop at any time during the course of this disease just as it may develop from any hemolytic streptococcus wound. The writer has seen it just three times in the 45 or 50 cases of hemolytic streptococcus gangrene which have come under his observation.

It seems likely that Fournier's cases of gangrene of the scrotum penis and vulva belonged to the hemolytic streptococcus gangrene group. When he made his early reports, the cause was not known but some of Fournier's pupils who studied the disease in later years believed the streptococcus to be responsible. Bodin however reported a case of gangrene of the vulva in which there were not only streptococci but fusiform bacilli and spirilla which he thought were significant. Millan and Nativelle believe that they have found a specific organism of the *Bacillus proteus* group which produces gangrene of the skin in animals and is they think, the important factor in human gangrene of the skin. However in 13 of 14 they found it associated with a streptococcus (not further classified) and they admit that they believe that the

streptococcus opened the door to the invasion of this organism. They found their organism in cases which were not at all alike clinically. Some were acute and others chronic. The acute cases which they describe may very well fall into the hemolytic streptococcus gangrene group. The organism which they found seems more likely to have been a secondary invader. Culturally it can hardly be distinguished from other organisms of the *Bacillus proteus* group. It grows aerobically and profusely in all media. It spreads very quickly over a blood agar plate and when present makes the recovery of associated organisms very difficult. This prolific growth would lead one to believe that when it is not found it is surely absent from the lesion. This can not be said of organisms more difficult to grow or organisms requiring anaerobic environment. The fact that Millan's organism was not recovered more often in the series of streptococcus gangrene cases seen by the writer in China which were previously reported (60) and is not often found in gas gangrene would seem to indicate that it is not a common or an important factor in the production of either of these forms of gangrene. Although it may occur more often in gangrene of the scrotum than in gangrene elsewhere because of the proximity of the anus, it was absent in the two cases of fulminating gangrene of the scrotum which the author has seen, both of which were typical hemolytic streptococcus gangrene. Bodin also in reviewing the subject of fulminating gangrene of the genitals, does not concede the theory of Millan and Nativelle that their *Bacillus gangrene cutis* (which was absent in his case) is of any significance as the cause of fulminating gangrene of the genitals.

The differential diagnosis of these acute diseases may be conveniently summarized in chart form (Table I)

CHRONIC GANGRENE

Cases of chronic infectious gangrene may be classified into three or four important subdivisions. Their differentiation is clinically more difficult than that of the acute cases. Each type has a number of distinguishing characteristics although in some instances the diagnosis may have to await a bacteriological

TABLE I.—DIFFERENTIATION OF ACUTE CASES

Name	Etiology	Symptomatology	Pathology	Treatment
Gas gangrene	Deep wound into muscle. Gram positive spore forming anaerobic rods. Early development of various kinds of associated bacteria.	Sudden onset. Profound general symptoms. High fever rapid pulse, apprehension, irritability. Relatively mild local signs. Limited redness, swelling and edema of skin. Crepitation. Dusky wound margins. Browning of skin. Limited gangrene.	Extensive death of muscle. Fibers broken by gas formation. May spread whole length of a single muscle. Exudate loaded with gram positive rods. Relatively few pus cells. Negative chemostats for W. B. C.	Prompt operation. Removal of all foreign bodies and dead tissue. Complete debridement of wound. Early administration of large quantities of polymyxin or specific serum.
Hemolytic streptococcus gangrene	Superficial wound. Pure culture hemolytic streptococcus. No other bacteria or late occurrence of a few other species after gangrenous skin has separated.	Sudden onset. Relatively mild general symptoms. Low fever but rapid pulse. Limited but diffuse anesthetic. Allergic local signs. Extreme redness and edema without sharp margins. Irregular dusky areas on third, fourth, or fifth day. Blisters and bullae. Rapidly developing extensive gangrene.	Extensive necrosis of subcutaneous tissues with a wide zone of sterile edema beyond the limits of necrosis. Heavy exudation of fluid and polymorphonuclears at first and later large mononuclear phagocytes. Bacteria found all through the necrotic subcutaneous fat and in the blisters and bullae. Thrombosis of some of blood vessels to overlying skin which becomes gangrenous.	Prompt operation. Long incisions to the limits of the subcutaneous necrosis. Release of all tension. Removal of necrotic tissue as soon as possible with minimum of bleeding. Hot applications of moist heat until subsidence of cellulitis. Skin grafting if defect is extensive.
Frysjael	Superficial wound. Pure culture of hemolytic streptococcus. No associated bacteria.	Sudden onset. Profound general symptoms. Chill. High fever. Rapid pulse. Apprehension, irritability. Slightly but steadily spreading area of redness with little or no swelling. Sharp raised margins.	Slight swelling and thickening of skin. No edema of subcutaneous fat. Bacteria in and beyond advancing area but not in center of lesion.	No operation. Soothing local applications. Ultraviolet light. Serum in severe cases.

analysis. Fortunately the progress of these diseases is slow and time is given for a bacteriological study which may be used as the basis for treatment. While all of these groups are characterized by some distinctive clinical features it seems certain that in each type the characteristic lesions are produced not by one organism as in the acute cases but by a special combination of two or more organisms. These diseases may therefore be called synergistic infections. They may be conveniently named as follows: (1) post operative progressive bacterial synergistic gangrene of the abdominal or chest wall, (2) gangrenous impetigo (ecthyma) (3) fusospirochetal infection of the skin, (4) amœbic infection of the skin.

POSTOPERATIVE PROGRESSIVE BACTERIAL SYNERGISTIC GANGRENE

One of the most striking examples of chronic gangrene of the skin is that which occasionally follows the drainage of a deep abscess either in the peritoneal cavity or in the chest. Considerable interest has been taken in this condition since 1924 when Cullen described a case which was thought at the time to be first on record. It has been reported so frequently since then that there seems to be no doubt that it occurred frequently before that time and was reported but the titles as they appear

in the *Index Medicus* or *Surgeon General's Library Index* fail to reveal these reports definitely and they are obscured by the great mass of literature on the general subject of gangrene. Since Cullen's publication cases have been reported by Brewer and Meloney, Alexander Shipley, Gillespie, Hellström, Freeman, Mayeda, and more recently by Ballin and Morse (Case 4), Lynn, Meloney (63), Baker and Terry, Horsley (Case 1), Carol and Kappis (Case 3). In this group also belong the cases of Christopher, Ballin and Morse (Case 2), Poate and Patterson all of which involved the chest wall following the drainage of an empyema. A few cases have been reported which developed spontaneously, e.g., Luckett and Kappis (Case 1), or after clean operations in poorly nourished tissue, e.g., Kappis (Case 2) or after operations on frankly infected tissue, e.g., Probst and Seelig. Inasmuch as anaerobic cultures were not made in these cases and the clinical course is not perfectly clear we cannot say with certainty whether or not they belong in this group but it would seem to be possible for the organisms causing this infection to be introduced into the tissues of the abdominal wall from without rather than from a deep abscess.

Symptomatology. In the majority of the cases which have been reported the gangrene has followed the drainage of a peritoneal

abscess. It usually begins to appear about the end of the first or second week after operation either as an infection of the whole wound or as a localized induration about retention sutures. At first the wound becomes red, swollen and tender. Within the next few days the wound margins or the stitch holes develop a carbuncloid indurated appearance. The center of activity becomes purplish in color while the outer zone takes on a brilliant red tint. The whole region becomes exquisitely tender. *This symptom is an outstanding feature of the disease.* Within a few days the purplish areas become frankly gangrenous. The color of the dead skin changes to a dirty greyish brown and the surface is dull like uede leather. The purple zone spreads outward into the red and as it does so the skin becomes swollen and stands up above the normal skin level. The central side of the purple zone toward the gangrene is sharply demmed but on the outer side it fades off into the red zone which slowly advances in all directions. The gangrenous skin is firmly adherent to the purple zone and there is very little undermining of normal skin. As the process advances, the gangrenous skin liquefies on its inner margin so that as it encroaches on the purple zone and the circumference of the whole lesion enlarges the width of the three zones remain fairly constant. As the inner margin of the gangrenous zone liquefies it leaves exposed a base of granulation tissue which gradually enlarges. The destruction of the dermis is not always complete and here and there some deep islands of epithelium from sweat glands or hair follicles may start patches of regenerating skin epithelium. Usually there is very little general reaction manifested either by fever or anemia and the patient remains in fairly good general condition although as the process goes on he is gradually worn down with discouragement and pain. The reports of all but the most recent cases indicate that the true nature of the lesion was not recognized until there had been extensive destruction of the skin. In several cases practically the whole surface of the abdominal wall, and in one case the whole back became involved. In a number of cases the lesion spread downward from the abdomen to the thigh.

Etiology. In most of the cases reported in the literature only routine bacteriological studies were made. They yielded a variety of organisms none of which seemed to be of special significance. Special methods, however were used in the study of the second case reported by Brewer and the writer (11) as well as in a subsequent case (63) and since they yielded identical results the findings seem to be significant. In the study of these cases an effort was made to determine all of the organisms present not only in the gangrenous tissue but in the spreading periphery of the lesion. This was possible in the first case when, after conservative measures had been employed unsuccessfully a wide excision of the lesion was done and the specimen taken immediately to the laboratory. Multiple cultures were then made from the subcutaneous fat at the periphery of the lesion inward toward the gangrenous zone. A micro-aerophilic non-haemolytic streptococcus was found in pure culture at the periphery of the lesion not only in the red zone but just beyond it in the relatively normal tissues at the very margin of the specimen and far from the area of gangrene. In the gangrenous tissue itself this organism was found to be associated with a haemolytic *Staphylococcus aureus*, and a diphtheroid bacillus. The diphtheroid bacillus was entirely non-pathogenic for animals when injected alone or with either of the other organisms. When the streptococcus and staphylococcus were injected in pure culture into animals no lesion was produced but when half doses of each organism were combined and injected a gangrenous process developed which spread during the course of 3 or 4 days and simulated to a considerable degree, the lesion in man. With this demonstration that these organisms could do something together which they could not do alone, the theory was advanced that the disease was the result of a synergistic action of the two organisms, the non-haemolytic micro-aerophilic streptococcus being the essential organism in the zone of advance, in some way preparing the ground for the gangrenous action of the combined organisms. When the second case appeared, an opportunity was given in a single case to study two lesions both of which yielded the

same result. Again the micro-aerophilic non-haemolytic streptococcus was found in pure culture at the periphery and it was associated with a haemolytic *Staphylococcus aureus* in the gangrenous area. No diphtheroids were found. The synergistic experiments already described were repeated in animals over and over again. This seemed to offer definite confirmation of the theory of bacterial synergism as the cause of this disease. It is hoped that other investigators using the same methods elsewhere will endeavor to confirm the findings. It should be remembered that this micro-aerophilic streptococcus is not a strict anaerobe and will grow aerobically after a number of artificial transplants in media with a reduced oxygen tension and it is quite possible that in some cases it may be obtained aerobically from the exudate at the gangrenous margin of the lesion even on primary culture. I believe that this has been done in those cases which were reported to have yielded a non-haemolytic streptococcus. But when a study is made of the periphery of the freshly excised lesion in the red zone it is likely that this organism will only be obtained by anaerobic methods. It corresponds to *Streptococcus evolutus* of Prévot (76).

In the 2 cases just summarized the organism which Milian and Nativelle described was not found. This would seem to indicate definitely that it is not a causative factor in this disease. It may however contaminate the wound just as *Bacillus coli*, *Bacillus welchii* or any other intestinal organism may occur in a wound without necessarily taking part in the infection. (See reports of Cases 1 and 2 in which this occurred and Case 3 in which it did not occur.)

Owing to the fact that a number of authors (e.g., Cole and Heideman) have reported the presence of amœbæ in similar lesions a careful study made in all 5 of these specimens by three different well trained parasitologists and in none of the 5 cases personally seen by the writer has there been anything suggestive of the presence of amœbæ in the tissues or in the exudate. The writer believes that this lesion may be secondarily contaminated with the bacillus which Milian has described and also with amœbæ but the evidence is strong that

these are not essential for the production of the lesion. Practically all of these cases have occurred following the drainage of a deep abscess either in the peritoneum or in the chest. In the abdominal cases the organism presumably came from the intestine as it is a common inhabitant of the alimentary canal. In the chest cases the original source of the streptococcus would seem to be either from the mouth or from infected emboli which were thrown off from thrombosed vessels in the peritoneum.

Treatment. In most of the cases which have been reported the wounds were partially closed by suture. This tissue tension in the presence of contamination may have favored the establishment of the infection. This suggests as a prophylactic measure that all skin wounds be left unsutured when peritoneal abscesses or chronic empyemas or lung abscesses are drained. The chronicity of this condition has afforded the opportunity of trying to cure it by many methods. Certain of the reports reflect the ingenuity and persistence of the surgeons in using all sorts of chemical and serological agents both generally and locally in the face of a baffling problem. In almost every case conservative methods including local excision of the gangrenous margins have failed to check the advance of this process but radical removal of the lesion including the outer zone of redness, either with the knife or with the cautery has almost invariably resulted in prompt disappearance of the disease. The defect left by this radical operation has then very quickly responded to skin grafting. In the present state of our knowledge with regard to these infections this treatment should be instituted within a few days after the diagnosis has been made. When we learn something more about the interaction of these organisms and find some way to interfere with their action perhaps more conservative measures will be effective. The writer prefers the knife to the cautery because there is less injury to the tissues and healing does not have to wait upon the separation of the tissue which has been destroyed by the cautery. There is very little to choose between the scalpel and the 'radio knife'.



Fig. Case. Note the two separate areas of gangrene firmly adherent at the scalloped margin. Immediately beyond that is the raised purple zone merging into a red zone which fades off into normal skin.

Recent cases. During the past year the writer has seen three more typical cases of this kind which will be briefly reported here.

CASE 1. C. H. Presbyterian Hospital, Unit History No 323125 a man 63 years of age a private patient of Dr F. B. St. John came to the hospital in December, 1931 with a 6 month history of increasing difficulty in bowel movement. It was found that he had a carcinoma of the sigmoid colon with considerable dilatation of the gut above it. A preliminary caecostomy was done with a tube held in the cecal wall by two pursestring sutures. Two sutures were taken in the external oblique aponeurosis and two in the skin. On the eighth day the upper angle of the caecostomy incision was found to be red and swollen the skin sutures were removed. On the twelfth day the upper margin of the wound at the outer end became purplish in color around the outer suture hole while the inner end of the wound began to show evidences of early involvement. The whole area became red swollen and exquisitely tender. Within a few days the margin of the wound and the area around the suture hole became frankly gangrenous and the purplish zone and red zone gradually spread outward. Just at that time an almost fatal coronary episode diverted attention from the wound. The process continued to spread slowly in two directions from the upper and lower ends of the wound. On the twenty-seventh day the writer was asked to see the patient, at which time the lesion had the fol-

lowing appearance (see Fig. 1). There was a large involved area in the right lower quadrant which was oval in shape and oblique in direction corresponding to the incision made for the caecostomy. At the inner and outer ends there were two areas of gangrene which were separated from one another: a circular one at the lower end and an oval one at the upper. The lower and outer margin of the wound was slightly rolled in and the fecal fistula about 1 centimeter in diameter near the center of the wound, was surrounded by pale granulations. In the two gangrenous areas the dead skin was firmly adherent. On the lower lesion it measured about 2 to 3 centimeters in diameter and on the upper lesion about 2 by 6 centimeters. The outer margin of gangrene was scalloped at the line of demarcation and the living skin for a distance of 2 to 3 millimeters was dark purple. Beyond that for a distance varying from 5 to 10 millimeters there was a grayish purplish zone which stood up from the skin surface like a plateau. Beyond that the skin was very red for a distance varying from 2 centimeters below to 5 centimeters above. The outer margin of redness was not clearly defined but faded off rather quickly into normal skin.

On the next day the whole lesion was excised with complete cessation of pain. The gangrenous process did not recur and 5 days later it was possible to proceed with a Mikulicz operation for the sigmoid carcinoma in the left lower quadrant. The denuded area on the right side rapidly granulated over and was covered with small skin grafts 3 weeks after excision.

When the lesion was removed it was taken to the laboratory and careful cultures were made of the subcutaneous tissue in the periphery of the lesion, after the skin surface was painted with 7 per cent iodine and the deep surface was seared. In three different places the micro aerophilic non-haemolytic streptococcus (*Streptococcus evolutus* of Prévot) was found in pure culture by anaerobic methods. Cultures from the gangrenous margin yielded a multiplicity of fecal organisms and the plates were overgrown with *Bacillus proteus* so that further identification was impossible. A careful microscopic search for amebae on the surface of the lesion and in the tissues revealed nothing resembling those organisms. Staphylococci and streptococci were abundant in the tissues at the gangrenous margin and streptococci were found in smaller numbers out toward the periphery of the lesion.

CASE 2. A private patient of Dr. Roswell L. Schmitt, Morristown, New York, a single American school teacher of 63 years was admitted to the Horton Memorial Hospital, Morristown, New York, on August 11, 1931 as Patient No. 4506 with a diagnosis of acute appendicitis with abscess. Operation was performed immediately after admission. A right rectus incision was used. The appendix was found extending downward over the brim of the pelvis and buried in a mass of adhesions including loops of the small intestine and possibly tube and ovary. On separating these adhesions, thick green



Fig. 2. Case 2. Note the lower right rectus incision and the large area of granulations surrounded by a large horse-shoe shaped zone of gangrene extending almost to the costal margin. Beyond the gangrene there is a raised purple zone merging into a brilliant red zone which fades off into normal skin. On the surface of the granulation tissue there are three small areas of regenerating epithelium which are not clearly shown.

pus was liberated and a necrotic appendix was released and removed. Two cigarette drains were placed down to the abscess. Dermal sutures were used for the skin.

The wound drained copiously. On the fifth day after operation the patient complained of soreness in the wound. The discharge seemed to be fecal. The skin edges became inflamed, so the skin sutures were removed and the wound edges were separated. The inflammation increased and the wound margins gradually developed a carbuncular appearance. Dressings became extremely painful, the edges of the wound then gradually became gangrenous and a line of demarcation appeared. Around the area of gangrene was a purple zone and outside of that the skin was very red for a distance of $\frac{1}{2}$ to 1 inch. These zones gradually spread outward and the inner margin of the gangrenous skin liquefied leaving a floor of granulation tissue. During the next 65 days, in spite of all kinds of local applications and general measures to build up the patient's resistance the lesion continued slowly to progress. By the seventh postoperative day the gangrene had extended to include most of the skin of the abdominal wall. The writer was then asked to see the patient. At that time the lesion presented the typical appearance in the spreading margin but the red and purple zones were narrower than in Case 1. The gangrenous zone varied in width from 0.5 to 4 centimeters. There was a large area of granulation tissue with three islands of regenerating epithelium (Fig. 2). Radical excision was advised and this was accomplished with a scalpel. The line of excision was carried well outside of the red zone. Cultures, which were made in the operating room from the line of incision on semi-solid 1 per cent dextrose veal agar showed a pure growth of non-hemolytic streptococci

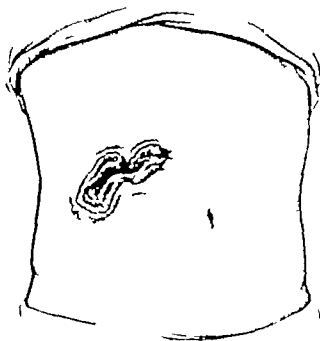


Fig. 3. Case 3. Note the upper right rectus incision which has healed and the lateral stab wound used for drainage. The area of gangrene is bilobed corresponding to the retention sutures of the second operation. The zone of gangrene is scalloped at the outer margin where it is firmly attached to the raised purple zone. Beyond that there is a wide zone of redness extending up over the ribs margin and across the scar of the first operation. The granulation tissue is narrow with the drainage opening at the upper end.

Cultures made from the necrotic edge of tissue showed streptococci, staphylococci and gram negative bacilli on several different media (blood agar, plain agar, dextrose agar and plain and dextrose broth). These organisms were not further identified. The specimen was taken to New York and 4 hours later cultures were made from various parts of the lesion. All of the cultures were overgrown with *Bacillus proteus* but by differential heating this organism was killed and the micro-aerophilic streptococcus was recovered. The histologic examination of the tissues revealed staphylococci and streptococci in the tissues but no amorphous debris was found after careful search. Following excision dakinized dressings were used for 6 weeks at which time the wound was clean. Thiersch grafts were then applied and the patient made a complete recovery.

CASE 3. A private patient of Dr. John H. Carlisle, Passaic, New Jersey. M. S. aged 57 years was admitted to the Passaic General Hospital, Passaic, New Jersey as Case No. 75668 on October 30, 1932. For 12 years the patient had suffered from duodenal ulcer. On two occasions X-rays were taken which showed a definite ulcer in the first part of the duodenum. On the evening of October 29, he had a supper of oyster stew and went to bed fairly early

feeling quite well. About midnight the ulcer perforated. He was not seen until the following morning and operation was performed at 1 p.m., 13 hours after the perforation.

A perforation was found on the anterior surface of the first part of the duodenum. A simple suture was done and reinforced with a flap of fat so that the closure was thought to be quite satisfactory. The wound was closed but drainage was provided through a stab wound on the right. This was thought necessary because the gall bladder and structures in Morrison's pouch were covered with fibrinoplastic exudate. Cultures were not taken. After operation he perspired in running a low temperature. On the twenty-seventh day it was evident that he had a subphrenic abscess and an intermuscular incision was made under the right ribs. When the peritoneum was opened, pus was immediately encountered. Culture from this pus yielded no growth with aerobic technique. No anaerobic cultures were made. No liver abscess could be made out. Two cigarette drains were placed in the abscess and the wound was closed in layers around the drains with two retention sutures for the skin. Following the drainage of the abscess, the temperature fell somewhat but continued around 100 to 101 degrees in the afternoons. There was a profuse drainage of pus. On the fifth day the wound was swollen and showed marked infection. The drains and the skin sutures were removed. The next day the old stab wound scar broke down discharging pus. On the eighth day there was considerable necrosis of the wound margins, most marked where the tension sutures had been placed. The patient complained of a great deal of burning in the wound and in the abdominal wall extending back along the course of the spinal nerves. The necrotic margins were cut away and various antiseptics were used but the infection continued to spread. On the fourteenth day the infection began to spread more rapidly toward the flank. A diagnosis of symbiotic gangrene was then made and the writer was called to see the patient. The lesion at this time appeared as follows: The upper right rectus incision was well healed. In the right upper quadrant there was an area showing a striking similarity to the lesion in Case 1 (see Fig. 3). There was a zone of gangrenous skin from 1 to 2 centimeters in width, a raised purple zone outside of it from 7 to 10 millimeters in diameter and outside of that a brilliant red zone from 1 to 3 centimeters in width which gradually faded off into normal skin. There was a narrow strip of granulation tissue on the floor of the wound and a sinus opening near the center. Below this lesion there was a small scar representing the original drainage tract. A wide excision was advised and operation was performed within an hour. The line of excision was carried about 3 centimeters beyond the reddened area. The skin and superficial fat were excised down to the fascia. The wound was dressed with fine meshed gauze wet with Dakin's solution. On the sixth day the defect was covered with pinch skin grafts and rapidly epithelialized.

Before operation cultures were made from the pus at the mouth of the drainage tract and from the gangrenous skin. At the time of operation bits of subcutaneous fat in the line of excision were cultured. After operation the specimen was taken to New York and within an hour of the time of its removal the skin was painted with metaphen and the deep surface was seared and further cultures were made of the subcutaneous fat at varying distances from the margin of the specimen toward the gangrenous zone approaching it from the deep surface as well as through the skin. Half of these cultures were incubated at 37.5 degrees C aerobically and the other half in an anaerobic jar. From the drainage tract and from the slough the micro-aerophilic non-hemolytic streptococcus greatly predominated but was associated with hemolytic and non hemolytic *Staphylococcus aureus* and *Staphylococcus albus*. From the subcutaneous fat away from the zone of gangrene the micro-aerophilic non hemolytic streptococcus was found in pure culture in 3 of 5 taken from the skin side and in 4 of 5 taken from the deep surface. In 2 of the 5 from the skin side, it was associated with aerobic spore forming rods evidently skin contaminating organisms which resisted the iodine. In the fifth culture from the deep surface the streptococcus was associated with a *Staphylococcus albus*. The cultures from the line of excision in this case yielded no growth. A careful study of the tissue taken for pathological examination failed to reveal anything resembling amoebae.

All 3 of these cases yielded the microphilic streptococcus in pure culture at the periphery of the lesion. Two of them were contaminated by a bacillus of the proteus group in the area of gangrene which made difficult the demonstration of other organisms although staphylococci were seen in the tissue sections and in the mixed culture. The third case did not yield a bacillus of the proteus group but yielded *Staphylococcus aureus* and *albus* in the slough. We believe that these 3 cases amply confirm the conclusions reached after study of the 2 cases previously reported namely: that the essential organism in this lesion is the micro-aerophilic non hemolytic *Streptococcus evolutus* (Prévot) but that the gangrene which is characteristic of the infection occurs only when this organism is in symbiosis with some other species—generally some variety of staphylococcus.

GANORENOUS IMPETIGO (ECHTHYMA)

For a good many years reports have appeared in the literature describing a chronic gangrenous disease of the skin appearing in

undernourished individuals both young and old who were generally in a low state of nutrition and were frequently suffering from recurrent attacks of dysentery. It has been given many names by the dermatologists, among them *echthyma*, *pyoderma gangrenosum*, *impetigo gangrenosum*, *dermatitis gangrenosa* etc. etc. Recently such cases have been described in the periodical literature by Hartzell, Kitchmann and Kreibich, Wende and Bentz, Hu, Brunsting, Goeckerman and O'Leary, Morrissey and Reynolds, McCarthy and Fields and others. Most of the textbooks, Unna, Stelwagon, Sutton, MacLeod, Hazen and Andrews have stated that this disease is simply a severer and deeper form of impetigo, but Shamberg was of the opinion that they were distinct.

Symptomatology. The lesions are usually multiple and show various stages of development, one lesion following another in rather rapid succession. They occur most frequently on the scalp, face and abdomen but may be found on any part of the body. They generally start as small vesicles surrounded by a red zone. The center then becomes dark and gangrenous and depressed. The lesion increases in size slightly and occasionally two or three neighboring lesions may coalesce but even the coalesced lesions seldom measure more than 1 or 2 centimeters in diameter. The disease is contagious and frequently occurs in several members of a family at the same time. Likewise the patient inoculates other areas of his body. As new lesions develop the old ones frequently dry, the necrotic skin comes off as a scab and a scar is left behind. The larger and deeper lesions, however, may persist for a long time. The gangrenous center then separates at the margin leaving a ring of depressed ulceration from the center of which the gangrenous plaque stands up like a button. If this separates from its base a clean ulcer is left which slowly heals. This condition may last for months or years with exacerbations and remissions and frequently a crop of small fresh gangrenous lesions may develop after a recurrence of diarrhoea or colitis.

Etiology. The cause of these lesions has been variously explained by different authors. Most dermatologists consider this condition to

be a serious form of impetigo. The onset of the lesion with vesiculation makes this seem plausible. The organism generally attributed to be the cause of impetigo is the hemolytic *streptococcus*. Some authors have attributed *echthyma* to the action of *Bacillus pyocyaneus*, others to *staphylococci* and still others to other *streptococci*. One of these cases died with a general sepsis in which three different organisms were successively found in the blood (42). This finding leads to some uncertainty with regard to their rôle in the etiology of the disease. Leloir in 1880 found both *staphylococci* and *streptococci* in 5 of these cases but he was unable to produce the disease in animals with these organisms in pure culture and thought that there might be some other etiological agent. Brunsting, Goeckerman and O'Leary regularly found a hemolytic *streptococcus* and a *staphylococcus* in the lesions and following the suggestion which the writer made with regard to progressive postoperative gangrene they attributed the disease to a synergistic action of these organisms. With these two organisms in combination they were able to produce similar lesions in animals. These authors did not explain the association of this disease with colitis or dysentery. Fox believed that if cultures are made early while the lesions are still vesicular the hemolytic *streptococcus* will be found invariably in pure culture but later when the gangrene develops *staphylococci* are present also. He did not suggest the possibility of synergism between the two. In studying this disease anaerobic cultures have rarely been made.

Treatment. Hartzell's case, although it resembled the others in its onset, differed from them in that excision of the lesions was the only method which effected their disappearance. He said that when the lesions were thoroughly excised together with a considerable margin of sound skin, the wound thus made, rapidly healed. If, however, all of the infected tissues were not removed, as happened frequently, the wound became a steadily enlarging gangrenous ulcer with firm elevated borders like those which resulted from untreated lesions. There was no bacteriological study of Hartzell's case. Hartzell has been the only one to advocate complete excision of

these lesions, and his case may have been different from the others for in almost all of the other cases reported there was spontaneous healing following the separation of the necrotic tissue. Various and sundry local medications have been applied by different authors most of which had some measure of success. In a good many cases while the individual lesion healed recurrences dragged on for months or years. Most of the writers however believe that the majority of these cases will recover if general nutritional measures are instituted and if the usual methods of treating impetigo are continued industriously.

FUSOSPIROCHETAL INFECTION OF THE SKIN

A third type of chronic gangrene is represented by the foul infections developing in wounds made by human bites or in wounds which have been contaminated by mouth secretions. Leeuwenhoek was probably the first to observe the spirochætae, the spirilla and the fusiform bacilli which frequent the human mouth but the classic work of Miller in 1890 offered the first comprehensive description of the mouth organisms. In 1894 Plaut (7) suggested the causative significance of the spirochæta and spirilla in certain of the non-diphtheritic infections of the throat and 4 years later Vincent stressed the rôle of the fusiform bacilli without recognizing the prior observations of Plaut. In 1905 Plaut and Vincent debated the question. In 1896 Vincent (91) had observed spirochætae in cases of hospital gangrene and believed them to be responsible for it. Eggers, in 1915 in the course of a morphological study of over 2,000 smears from chronic skin ulcers in patients in various parts of China, found spirochætae in about 10 per cent. They were frequently found in the lesions commonly known as "tropical sore." Plaut (74) later found the combination of fusiform bacilli and spirochætae in two "noma like" lesions of the skin.

Stiles and Hasall, in their classification of the protozoa reported for man state that the spirochætae which are pathogenic for man are limited to the *Treponema* and *Leptospira* groups. Smith, in his recent book on fusospirochætal diseases lists four species of

spirochætae and three types of fusiform bacilli which occur in the human mouth and which have been found in human infections.

Hospital gangrene practically disappeared when surgeons began to have a little understanding of bacterial contagion and infection. It is almost certain therefore that it was an infectious type of gangrene. Whether or not it was due to a specific organism or to a specific combination of organisms not including the spirochætae or to the fuso-spirochætal group as Vincent claimed may never be determined. Warren believed that the term included a number of different acute and subacute forms of infectious gangrene. The writer cannot add anything to the solution of this problem from personal experience but agrees with Warren after studying a number of the reports which appeared in the medical literature following the Civil War and later.

In recent years gangrene of the skin and subcutaneous tissues, in which the fuso-spirochætal organisms play a part has generally occurred following the implantation of mouth organisms into the tissues by human bites. Flick has recently reviewed the literature and added 5 cases to the ones which had been reported previously by Hultgen, Peters, Hennessy, Madras, and Fletcher, Pilot and Meyer, Fuller and Cottrell, Bower and Lang.

A human bite invariably contaminates the wound with a mixture of organisms. Bates says that the police surgeons fear the severity of these infections more than any other type of infected wound. Usually gangrene does not develop in these cases unless there is a mixture of organisms which includes non-hæmolytic streptococci, fusiform bacilli and spirochætae. Although spirochætae are never found alone in these infections the worst cases are certainly those in which spirochætae are present. The infection almost always occurs either when a human being voluntarily bites another or strikes a blow with the hand which is cut by the teeth of the intended victim. The wound is usually a lacerated wound of considerable depth, but cases have been reported in which the injury was very superficial and one case followed the picking of a superficial blister with a pen knife with which the patient was accustomed to pick his teeth. It is surprising

that more wicked infections do not develop in wounds which have been sucked, for this is a common practice. It is probable that organisms are not planted in the depths by this procedure.

Symptomatology. There is usually some evidence of inflammation within the first 2 or 3 days after receipt of the injury and this steadily progresses. The exudate becomes foul, the margins of the wound are shaggy, bleed easily, and take on a dark grey-green appearance. The infection may spread fairly rapidly into the neighboring bones and joints. It burrows down into the deep spaces and may work up again toward the surface and break out at some distance from the original wound. Thus multiple sinuses are produced or if incisions are made in various places the wounds remain open and continue to discharge the foul smelling exudate. Unless the proper treatment is instituted these infections go on steadily for weeks or months with a progressive destruction not only of the skin and subcutaneous tissue but of the deeper structures.

Etiology. If smears are made from the foul exudate countless organisms are seen among them streptococci, fusiform bacilli and spirochaetae—the latter are better seen with the darkfield illumination. These organisms will develop only under anaerobic conditions and are grown best in or on special media. A great many serious human bites occur in which only streptococci and staphylococci are found but usually in these cases although infection is severe and the general symptoms marked, there is no gangrene of the tissues. Although hemolytic streptococcus gangrene might develop after a human bite such a case has not come into the experience of the writer. If gangrene is present, either the fusiform bacilli or the spirochaetae are usually to be found and the severer cases harbor both of these organisms. There has been some debate among the investigators of these Plaut-Vincent infections as to whether the fusiform bacilli and spirochaetae are two different organisms growing in symbiosis or represent two different stages of the same organism. Tunnicliff is of the opinion that spirochaetae develop from the fusiform bacilli. She reports that she has actually seen this development taking

place. However, this has not been confirmed by other writers who claim that although twisted forms of the fusiform bacilli do appear in old cultures, the spirochaetae which occur in these infections represent a different species and that it is a true symbiotic infection. Knorr goes further in stating that he has never seen a case of infection with either fusiform bacilli or the spirochaetae without streptococci being present also. He believes these infections are symbiotic in nature and that the streptococcus plays a necessary and an important rôle.

Treatment. Bates who has had considerable experience with infections of this kind now treats wounds caused by human teeth with radical excision as soon as they come to him. This he believes is an important prophylactic measure. When the infection has already gained a foot hold most authors have found that any temporizing measure is unsuccessful and they advocate fairly radical surgery which generally involves amputation of a finger or hand. The presence of spirochaetae has suggested the treatment of these infections with spirochaetocidal chemical substances and although arsphenamine has frequently been used without success, better results have been obtained with neo-arsphenamine. This should certainly be tried before any radical surgical procedures are used, but temporizing measures should not be continued if there is no very definite improvement. Otherwise extensive destruction of important structures may take place.

AMOEBA INFECTION OF THE SKIN

The ulcerative lesions of the intestine in which *Endamoeba histolytica* is found are well known. The most frequent parenteral site for the activity of this protozoön is in the liver and the lesion within that organ may be a single abscess or multiple abscesses. It is of interest that all efforts made toward artificial cultivation of amoebae in the absence of other organisms has failed. Likewise in the lesions within the body, the amoebae are almost always associated with some of the intestinal bacterial species (in symbiosis). In the early stages, the liver abscesses frequently yield these associated organisms on culture and the presence

of the amoeba is not suspected. In later stages after the infection has become established, cultures may fail to reveal bacterial organisms but scrapings of the abscess wall will yield living amoebae. It seems to be possible, therefore for the amoebae alone to maintain a lesion in the human body although in many of these cases there may be anaerobic organisms present which have not been revealed by culture.

Amoebic infection of the skin has been described by a number of authors practicing in regions in which amoebic disease is common. In most of the cases which have been reported the involvement of the skin has been secondary to the spontaneous or operative drainage of a liver abscess. Such cases have been described by Heimberger, Nasse, Daborn and Heymann, Heymann and Ricou, Gauducheau, Carmini, Cheng, Engman Jr and Henry, Meleney and others. A few cases of skin infection have followed some operative procedure on the large gut, e.g. Cole and Heideman, Marwitz and Van Steenis. By two observers, Maxwell and van Hoof, fistulas about the anus have been attributed to the action of amoebae.

Gangrenous lesions of the skin attributed to amoebae which seemed to arise without any direct connection with an internal focus of the disease have been listed only twice in the recent literature. In 1919, Engman, Sr and Heithaus reported a case which came under their observation and they fully described the course of the infection. In this case the disease developed secondarily in several of the lesions of impetigo from which the patient had been suffering. The amoeba which they described was assumed to be but was not definitely classified as *Endamoeba histolytica*. They included in their report 2 other cases which may belong to this group but the evidence is not perfectly clear. Similarly in a case reported by Hansen and Stark the findings are not absolutely convincing because the organisms were not found in the lesions although they were said to be present in the stools.

Symptomatology. In the cases which develop a gangrenous lesion of the skin secondary to the drainage of a deeper focus, there is always a period of days or weeks during which there

is no specific change in the wound. The drainage tract becomes red, swollen, and painful in a manner similar to that in many drained wounds. Then the edges become indurated, everted and raised above the surrounding skin which takes on a dark brown color with hyperpigmentation. As the necrosis spreads, the center of the lesion remains as an ulcerated surface covered with dark granulations having a color resembling that of raw beef which has been exposed to the air for some time" (Heimberger). The surface is covered with foul smelling exudate of thick brownish blood tinged pus with shreds of necrotic tissue in it. Usually the chief involvement is in the skin and subcutaneous tissue but the muscle may be involved in which case the whole wound becomes necrotic to a considerable depth, as in Engman Jr and Meleney's second case. In amoebic lesions which have no connection with a deep focus, Engman and Heithaus say that the infection with amoebae apparently must be preceded by an established infection with other organisms. This at once suggests the possibility of a symbiotic rather than a specific action. In such a case the infection remains relatively superficial. The spread seems to be in the cutis while the epidermis is involved secondarily and gives way. Glairy pus in small droplets may be expressed from the margin of the ulceration. This is said to be quite characteristic of the infection. If the proper treatment is not instituted the lesion continues to spread fairly rapidly in all directions until large areas are involved and the patient finally succumbs either to the involvement of a vital organ or to an intercurrent infection.

Etiology. In none of the cases, reviewed by the writer which have been attributed to amoebae have careful anaerobic as well as aerobic bacteriological studies been made. The bacterial factor either alone or in symbiosis with the amoebae may not have been given the attention which it deserves. It seems to the writer that one or all of the following conditions should obtain before it can be fairly stated that amoebae are participating actively in any infection: (1) There should be histological evidence of the invasion of the tissues by the amoebae or (2) they should be

found either by smear or culture in the advancing margin of the lesion, or (3) the lesion should respond to emetin treatment recognized as adequate for amœbic disease. The writer believes that the mere presence of amœbe on the surface of the lesion or in the exudate is no more evidence of their participation in the infection than the presence of *Bacillus coli*, *Bacillus welchii*, *Bacillus proteus*, or any of the other intestinal organisms is evidence of their activity in the tissues about a fecal fistula. In most of the cases in which amœbæ have been observed there has been no accurate determination of the type of amœba but in those cases having a direct connection with amœbic lesion of the liver or gut it is frequently assumed that the organism is *Endamoeba histolytica*. In the case of Heimberger and in the second case reported by Engman Jr and Henry Meloney there seems to be little doubt that *Endamoeba histolytica* was present and played an important rôle in the infection. It is of particular interest to note that in Engman and Heithaus's case, bacterial cultures yielded no growth aerobically. After such a long exposure to contamination it is surprising that there were not secondary contaminants capable of growth even if the organisms responsible for the impetigo had disappeared. The spectacular response both generally and locally to the emetin treatment in this case as well as in Heimberger's case is strong evidence in favor of the importance of the amœbæ in these infections. In the second case of Engman, Jr and Henry Meloney the invasion by the amœbæ of the whole thickness of the abdominal wall including the muscle is a strong argument in favor of the activity of the amœba in that case, although there was little response to emetin. The fatal outcome may have been due either to the extent of the amœbic lesion in the liver or the virulence of the associated hæmolytic streptococcus and *Staphylococcus aureus* in a patient with diabetes. In the first case presented by these authors although the organism found was almost certainly *Endamoeba histolytica* the evidence is not so clear that the amœba played an important rôle. No cultural studies were made of this lesion so that the factor of bacterial synergism could

not be weighed or measured. The amœbæ were found in the pus and on the surface of the wound but not in the depths of the tissue nor were they found in the apparently healing ulcer in the gut. It may have been a surface contamination. On the other hand the temporarily favorable response to emetin may indicate that the amœba played a partial rôle in the production of the lesion. In the case reported by Cole and Heideman there is still less evidence that the amœba, which was found in the pus but was not classified as a factor in the infection. The organism was present in the exudate but not in the tissues. There was little if any response to emetin treatment even though the pathology seemed to be localized in the skin lesion. The disease was finally controlled only by a wide cautery excision such as is required in the bacterial synergistic gangrene. No anaerobic cultural studies were made in this case but the onset and the clinical course were typical of the bacterial synergistic gangrene and similar to the 5 cases of that type mentioned previously in lesions of which no amœbæ were found after careful search by three parasitologists.

Treatment. In all cases of amœbic abscess of the liver, the possibility of skin necrosis after drainage must be kept in mind and precautions taken to avoid it. An attempt should be made to protect the skin wound at the time of operation. A two stage procedure might increase wound resistance to the infection. If a one stage operation is performed there should be complete relaxation of the wound with no attempt to close the skin and subcutaneous tissues by suture. If pathogenic amœbæ have been found, emetin hydrochloride should be given intravenously. If this medication fails and the disease is localized to the surface lesion it should be widely excised. In all of these cases inasmuch as the bacterial symbionts always play a rôle of greater or lesser importance, a careful bacteriological study of the lesion should be made before operation and cultures taken from various portions of specimen after excision if that procedure be necessary.

DIFFERENTIAL DIAGNOSIS

The differentiation between the groups of chronic infectious gangrene is difficult, particu-

TABLE II.—DIFFERENTIATION OF CHRONIC CASES

Name	Etiology	Symptomatology	Pathology	Treatment
Postoperative progressive bacterial synergistic gangrene	Essential organisms micro-aerophilic non-hemolytic streptococcus (<i>S. erythrae</i>) in the spreading periphery of the lesion, associated with staphylococcus in the zone of gangrene.	Usually follows drainage of perforated abscess, lung abscess, or chronic suppuration. Wound margins or retention suture takes after one or two weeks takes on a curdlike appearance. Usually differentiating into three skin zones, outer bright red, middle dusky purple, and inner gangrenous with central area of granulation tissue. Escalating pain.	Destruction of epidermis and upper layers of dermis occasionally leaving some deep remnants of epithelium which may later grow. Under gangrene, heavy polymorphonuclear exudation. Under purple zone, leucorrhoea. Under red zone, hyperemia. Many staphylococci and streptococci under gangrene. Scattered streptococci in the periphery.	Extensive excision of the whole lesion well beyond the red zone of advance, either with the electric cautery-knife or with the scalpel. Skin grafting.
Gangrenous impetigo (ecthyma)	Essential organisms hemolytic streptococcus and hemolytic staphylococcus	Usually occurs in debilitated persons especially those suffering from chronic dysentery. Lesions are usually multiple and may coalesce but are seldom large. Start as vesicles going on rapidly to pustulation and gangrene.	Usually superficial destruction of tissue with drying of the gangrenous skin, scab formation, and separation. Moderate polymorphonuclear exudation. Local invasion of staphylococci and streptococci.	Removal of crusts. Intravene local application of ammoniated mercury and meat. General antiseptic treatment.
Furunculopar gangrene	Essential organisms fusiform bacilli, spirilla, and spirochetes usually associated with non-hemolytic streptococcus	Usually occurs in wound contaminated with mouth secretions, e. g. lower lip. Early induration with gradual development of necrosis of wound edges with penetration to bones and joints.	Extensive sloughing of superficial and deep tissue with multiple scab formation. Organisms profuse in exudate and in the necrotic tissue.	Intravene intraveneous administration of neo-arsphenamine. Radical amputation if indicated.
Amoebic infection of the gangrene	Essential organisms Endamoeba histolytica associated with anaerobic streptococci, staphylococci, and local organisms.	Usually follows the drainage of an amoebic abscess of the liver. Margins round and everted. Granulations have appearance of raw beef covered with streaks of necrotic material. Glairy pus expressed from margin.	Extensive destruction of dermis with undermining and secondary destruction of epidermis. Polymorphonuclear exudation. Amoebae and bacteria present even in the stratum corneum in the tissues.	Extensive administration of creosote hydrochloride intravenously. Radical resection of the lesion if disease is limited to the skin and medication fails.

larly between the bacterial synergistic and the amoebic groups both of which usually follow an operative procedure. In the bacterial synergistic group there is no history of amoebic infection or evidence of deep amoebic lesion no amoebae are found either in the stools or in the exudate from the lesion or in the tissues and there is no response to emetin treatment. In the amoebic cases there is frequently a history of previous amoebic dysentery or a frank deep amoebic lesion. Amoebae are frequently found in the stools as well as in the exudate from the wound and in the tissues and the lesions may respond promptly often surprisingly to emetin treatment. In bacterial synergistic gangrene the lesion is extensive but superficial and develops slowly. It does not invade the muscle and the base of the ulcerated center is composed of active granulations which frequently reveal isolated islands of regenerating epithelium. In the amoebic infections the lesion is usually deeper. It develops more rapidly and it may involve the muscle. The granulations have a raw beef appearance and islands of regenerating epithelium are rare. Pressure on the margins produces glairy

pus in which the amoebae may be found. All of the cases of postoperative progressive bacterial synergistic gangrene which have been examined at the time of excision have yielded a micro-aerophilic non-hemolytic streptococcus in pure culture in the spreading periphery of the lesion while cultures in the zone of gangrene have revealed this organism in association with others. As far as the writer is aware the advancing margin of the amoebic lesions has never been examined bacteriologically but the exudate almost invariably yields beside the amoebae a combination of organisms which may contribute toward the severity of the infection. Until complete bacteriological studies have been made in amoebic cases there cannot be any satisfactory pathological or bacteriological differentiation between these two groups.

Gangrenous impetigo and fusio-spirochetal gangrene of the skin are more easily differentiated. The former almost always occurs in individuals suffering from some debilitating disease especially a chronic dysentery. The lesions are multiple and follow one another with great persistence over a period of months

or years. Fusospirochætal gangrene almost always develops in a wound deeply contaminated with human mouth secretions such as a human bite. Gangrenous impetigo usually starts as a vesicle which becomes gangrenous in a few days but does not spread widely or deeply. In fusospirochætal infection, the lesion progresses steadily and penetrates deeply to muscle tendon joint and bone with a massive destruction of tissue. Multiple sinuses are prone to develop and persist. From the lesions of gangrenous impetigo the hæmolytic streptococcus and staphylococcus may both be cultured. From the Plaut Vincent infections fusiform bacilli spirilla, and spirochæte may be found on smear or culture or with the dark field illumination but there is usually some type of streptococcus generally non hæmolytic, also present.

The differentiation of the types of chronic infectious gangrene may be conveniently summarized in chart form (Table II)

SUMMARY AND CONCLUSIONS

In this paper we have attempted to differentiate clinically as well as bacteriologically, the various types of gangrene of the skin and subcutaneous tissue due to the invasion of microorganisms. They may be conveniently divided into acute and chronic forms.

The acute types are essentially diseases caused by single bacterial species although their severity may be augmented by associated organisms. They comprise (a) gas gangrene and (b) hæmolytic streptococcus gangrene. Their differentiation from one another and from erysipelas is summarized in Table I.

The chronic types are essentially diseases due to a mixture of organisms growing in symbiosis. These organisms in pure culture are either innocuous or produce lesions which are not gangrenous. They comprise (a) progressive bacterial synergistic gangrene (b) gangrenous impetigo (c) fusospirochætal gangrene and (d) amœbic infection of the skin. Their differentiation is summarized in Table II.

The early differentiation of these infectious forms of gangrene is essential in order that the proper treatment may be instituted early. For in that way extensive loss of tissue may be

prevented the duration of illness may be shortened and lives may be saved.

Three additional cases of progressive postoperative bacterial synergistic gangrene are herein reported.

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REGENERATIVE CAPACITY OF THE EXTRAHEPATIC BILIARY TRACTS

CLINICAL AND EXPERIMENTAL STUDY

GEORGE HALPERIN, M.D., M.S., F.A.C.S., Chicago

From the Department of Surgery of Northwestern University

OPERATIVE procedures required for the repair or reconstruction of the extrahepatic bile tracts present a number of difficult problems and generally speaking constitute a difficult and ungrateful chapter in surgery. Cicatricial stenosis and partial or complete obliteration of the common bile duct as well as of the hepatic duct may be caused by the following conditions:

1. Congenital anomaly such as diverticulum of the common bile duct
2. Benign and malignant neoplasms involving the common bile duct, the head of the pancreas papilla of Vater, the gall bladder or the cystic duct
3. Inflammatory conditions (a) decubitus ulcer in the common duct caused by a stone (b) inflammatory induration of the lower end of the common duct, result of a large callous ulcer of duodenum (c) acute or chronic indurative pancreatitis
4. Postoperative strictures.

The first three groups are relatively rare. The greatest number of cases calling for repair or reconstruction is furnished by the postoperative group. The most frequent cause of postoperative stricture of the choledochus or the common hepatic duct is a technical error committed in a course of a cholecystectomy and passed unnoticed at the time. Occasionally stenosis has taken place after a supra duodenal choledochotomy done for exploration and removal of stones, regardless of whether the incision was drained or closed primarily. The use of a T tube especially if too early removed has been a not infrequent cause.

There is a group of cases in which stenosis developed in spite of faultless technique and in the absence of complications. Here belong cases of phlegmonous inflammation of the extrahepatic bile ducts in which the suppurative process ordinarily limited to the gall bladder extended to and involved the com-

mon bile duct. The stenosed duct in such an instance is analogous to a shrunken gall bladder the result of a purulent cholecystitis. It is noteworthy that such cases have been found only after an operative procedure and never primarily.

Much more difficult is the explanation of cases, fortunately rare, in which stenosis occurred after a meticulously carried out operation and in the absence of inflammatory adhesions. A possible explanation may be found in a constitutional predisposition to connective tissue hyperplasia. The use of a drain may be responsible in some instances for an excessive connective tissue reaction. As is well known, injury to the common or the hepatic duct in the course of a cholecystectomy has occurred in the hands of master surgeons and need not be charged to a lack of skill or care in the performance of the operation. Correct anatomical orientation is not always possible. Variations in the normal arrangement of bile ducts and blood vessels particularly in the presence of inflammatory conditions, make the recognition of the essential structures very difficult, at times impossible. Ruge in an anatomical study, made at the suggestion of Koerte examined 43 human cadavers and found that the cystic duct joined the common hepatic in one of three ways: (1) In 35 per cent of the cases at a sharp angle. (2) In 30 per cent the cystic ran parallel with the common hepatic for a variable distance before joining the latter. The two may be so closely bound as to make their separation difficult. It is this type that Delbet characterized as canal double hepato-kystique. (3) In 45 per cent of the cases the cystic duct ran a spiral course and joined the hepatic on its left side.

The subject of anomalies was further studied with essentially similar results by Kunze, Descomps, Rio-Branco, Eisendrath, Behrend, and others.

The operative injury is most frequently the result of inclusion of a part or of the entire thickness of the common bile duct or of the hepatic in the grasp of the forceps or ligature intended for the cystic alone. Next in frequency is the attempt to grasp blindly a severed, retracted, and spurting cystic artery. The injury, if recognized at the time of operation should be repaired immediately. Its later repair in a jaundiced patient with a tendency to cholamic bleeding, and in the presence of baffling adhesions and altered anatomical relations becomes an infinitely more difficult, if not an altogether hopeless task.

CLINICAL EVIDENCE REGARDING THE REGENERATIVE CAPACITY OF THE EXTRAHEPATIC BILE DUCTS

It is a well established fact that partial defects of the choledochus especially if they be longitudinal, heal spontaneously and only rarely display a tendency to scar contraction. The difficult problem is presented by cases in which so much of the duct is stenosed or destroyed that an end-to-end anastomosis is impossible. If the gall bladder is available a short-circuiting operation of cholecystogastrostomy or cholecysto-enterostomy saves the situation. Most of the cases under consideration, however have had a previous cholecystectomy. Doyen as early as 1892, did the first choledochorrhaphy over a buried tube. Halsted attempted the same in 1900. Both operations resulted in failure. When the gap between the proximal stump and the duodenum or the stomach is not too great, and if the duodenum can be mobilized the problem is relatively simple the *direct anastomosis* between the hepatic or the common duct and the duodenum giving excellent results. The first hepaticoduodenostomy was performed by Hans Kehr in 1902 (33) and was described in his "Die Geübte Technik der Gallensteinoperationen." W J Mayo (46 47) reported a successful hepaticoduodenostomy in 1905. The case was again reported 10 years later by himself and 16 years later Balfour reported the patient as being in perfect health. In cases in which a direct end-to-end anastomosis of the severed duct is impossible because of the

extent destroyed, or because of inflammatory conditions, or adhesions which make mobilization of the duodenum impossible artificial reconstruction of the duct is the only alternative left. For these difficult cases three methods have been advanced.

- 1 Plastic operation utilizing pedunculated flaps carved from the gall bladder wall stomach wall duodenum or jejunum as well as the use of a transplanted vein fascia etc.

- 2 A two step operation consisting first of forming an external biliary fistula from the gall bladder cystic common, or the hepatic duct. This fistula is cored out at a second operation and is implanted into duodenum or stomach.

- 3 Bridging the gap between the two ends of a severed duct, or between the proximal stump of the duct and duodenum or stomach by means of a rubber tube.

Hans Kehr (33 34) was the first successfully to employ a seromuscular flap from the stomach in one case (in 1907) and from the gall bladder in another, to cover a defect in the common bile duct. Stubenrauch in 1906 successfully employed a flap carved from the stomach in one patient. His attempts to perform the same operation in dogs were not successful. The recent experiments of Schrager and Ivy with the flap method proved that this procedure was feasible at least in dogs, provided that a tube fashioned out of gastric mucosal layer only was used. Ivy (personal communication) doubts however, that such tubes can be made fairly long without endangering their blood supply and thereby compromising the end results. Furthermore all of their dogs developed a hepatitis. Attractive as all of these methods may appear in theory or in animal experimentation, their practical application in human beings is seldom possible.

Priority in the use of the method of fistula implantation undoubtedly belongs to Czerny as correctly pointed out by Horgan in a recent monograph. Successful results with the method have been reported by Stubenrauch in 1906, by Kausch in 1914, and more recently by Lahey and by Walters. Kausch reported a case which functioned normally $1\frac{1}{4}$ years later. It was his conviction, however that

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Doberauer mentions one other case in the literature, that operated on by Kehr in 1905 and mentioned in his "Die Geuebte Technik der Gallensteinoperationen." In Kehr's case the gap amounting to 6 centimeters was bridged by a rubber tube sutured into the hepatic duct and introduced through a stab into the duodenum. The patient was well 2 years after the operation. In still another case reported by Liebold, Kehr approximated the posterior surfaces of the two ends with three sutures and then turned in a flap carved from the gall bladder to cover the defect in the anterior wall of the common duct.

Voelcker did not consider it safe to leave the catheter in. In his first case he solved the problem by leading the catheter out of the duodenum through a second stab and leading it out on to the skin.

Brewer in 1910 reported 1 case and Wilms in 1912 6 cases in which they employed the Jenckel procedure. The 2 last named authors have simultaneously adopted the step of allowing the buried tube to pass out of its own accord. In German literature this procedure is frequently referred to as the Wilms-Brewer operation. Wilms could explain the success in his cases only on the basis of the ability of the epithelium lining the ducts to regenerate rapidly along the prosthesis. McArthur a pioneer in this work particularly stressed the point that by constant duodenal and jejunal tug the catheter would ultimately be drawn into the intestine and be discharged per rectum. He reported eight successful choledochorrhaphies over a buried tube.

Feist has collected 24 cases of primary healing with the buried tube method up to 1925. To this number I have been able to add 18 more cases from the literature considered as successes by their authors. A brief summary with the postoperative periods reported follows. Jenckel had 7 cases reported from his clinic by Gerlach as being well 8½, 7, 6½ years later and shorter periods. Wilms reports 6 cases well for periods of from 3 months to 12 months. Verhoogen (10) 1 case, 1 year, Alessandrini 1 case, 6½ years. Doberauer, 1 case 3 months, Kehr (34) 1 case 2 years, Propping 1 case 2½ years. Hagyard 1 case, 6 months. Feist, 1 case 12 months, Voelcker,

2 cases, Lobmeyer, 1 case, Huebsch, 1 case, Martin du Pau, 1 case, Simon, 4 cases, Kuemmel, 1 case, Desplas, 1 case, Gernez, 1 case 4½ years, and Mann 1 case, well 5 months.

Three years after the first operation by Jenckel and 1 year before its publication (Jenckel did not publish it until 1910) Arthur G. Sullivan (59, 60) reported the operation successfully carried out in 8 dogs. The fact that Sullivan was undoubtedly the first to perform this operation in animal experiments, just as Jenckel was the first to perform it successfully in the human, suggests the propriety of calling it the Jenckel-Sullivan operation rather than the Wilms-Brewer operation.

The study of the cited cases prompts the following questions: Does a new duct form? Does the epithelium actually grow in to line the new channel? Does an ascending infection take place? What is the effect of a buried tube on the tissues? How long does the tube remain *in situ*? What happens after the tube passes? What are the end results? It is only fair to state that the literature contains a number of reports recounting frank failures and condemning the method. Enderlen Propping and Arnsperger were pessimistic about its value.¹ Magnus reported 3 consecutive failures with it, and Naegeli, 2. Brewer's patient developed obstruction symptoms 2 months after the second operation and died of cholæmic bleeding. To these cases should be added those of Cahen and of Hagler the patients dying of liver abscesses 5 and 7 months after the operation. It is safe to assume that failures are less likely to be reported than successes, and that a number of cases originally reported as successes subsequently developed stenosis with its dire effects.

Does a new duct actually form? Jenckel, Verhoogen, Wilms, Pels-Leuden and others answer this question in the affirmative. The explanation according to them is to be seen in the extraordinary regenerative capacity of the epithelium of the extrahepatic bile tracts. The epithelium grows along the prosthesis from the stumps and forms a new epithelial channel. Verhoogen and Wilms see an analogy in the remarkable regenerative capacity of the epithelium lining the urethra. The same

¹See discussion in *Zentralbl. f. Chir.* 1903, 19.

opinion is expressed by Judd and Burden as late as 1934 in a paper in which they discuss the histological structure of the common bile duct. They state "The lining epithelium of the common bile duct is possessed of extraordinary power of regeneration and quickly covers any break in its continuity. In fact it grows into and lines a new duct constructed from other tissue as was shown experimentally by Horsley.

I shall attempt to answer the question of new duct formation as well as the question of epithelial regeneration on the basis of post mortem evidence as well as on the basis of experimental data. In passing I wish to quote an opinion advanced by W. J. Mayo (47) in 1916. In discussing the various methods of reconstruction of the common bile duct he had this to say concerning the Sullivan method.

"This is by all means the simplest method of restoring the bile channel but unfortunately the newly formed channel is not mucus lined and we must expect that eventually contraction will take place after the tube slips into the intestine which will ultimately occur.

Does an ascending infection occur? It is my impression that more or less infection occurs in every case. It need not in every instance lead to liver abscesses, as in the cases of Cahen and Hagler but that a variable amount of cholangitis and hepatitis takes place is most evident from the frequent mention in the postoperative histories of these patients of chills, fever and jaundice. Jenckel and Wilms believe that formation of an oblique channel in the duodenal wall as *la* Witzel will do much to prevent an ascending infection.

The use of a buried tube apparently does not favor formation of stones but that it may lead to pressure necrosis is evident from at least two cases. Thus Freund removed a prosthesis which lay buried for 2 years and which led to stenosis of the papilla of Vater and caused attacks of jaundice and fever. Graff (cited by Feist) removed a tube in a case in which after 10 years of good health it led to formation of liver abscesses.

How soon does the tube pass? That depends principally upon the method of fixation and the kind of suture material used. There is no way of telling how long the tube remains in

the intestinal tract after it has passed into the bowel. In some instances the tube was vomited up.

What happens after the tube passes, as well as the end results themselves, cannot be accurately judged from clinical cases reports of which are limited to short periods of observation. The answer to these is closely linked with the question of whether new ducts are actually formed and whether these ducts are lined by epithelium.

From the evidence thus far adduced it is apparent that the much vaunted regenerative capacity of epithelium of the extrahepatic bile ducts is so far a conjecture rather than an established fact. There remain to be proved at least 2 facts, one that new ducts have actually formed and two that these newly formed ducts were lined by epithelium.

POSTMORTEM FINDINGS

In the consideration of many a clinical phenomenon we naturally turn to postmortem findings for elucidation. A search of the literature on this point brings to light 3 cases in which, after a reconstruction operation of the Jenckel-Sullivan type a postmortem examination was made. In one of these a histological study of the new duct was made.

CASE 1. This case was reported in 1913 by Cahen. Cahen performed a cholecystectomy in a woman for a fibrotic gall bladder containing numerous stones. The common duct was explored and a tube inserted. A biliary fistula resulted. The fistula closed at times giving rise to chills, fever, pain, and vomiting. At a second operation, 7 months later, Cahen found a complete stenosis of the common duct. The patient's condition on the table was desperate. Numerous adhesions and the extent of the gap between the hilus of the liver and duodenum made a direct anastomosis impossible. Cahen sutured a rubber tube into the common hepatic and introduced its distal end into the stomach as *la* Witzel. The tube was vomited up about 1 month after the operation. There was an improvement as to symptoms for a short time, later followed by diarrhea, loss of weight, and asthenia. Death took place 4 months after the operation.

Autopsy revealed that death was due to liver abscesses. In the duodenum, 1 1/4 centimeters away from the pylorus, there was found a round opening about 4 millimeters in diameter. When a sound was passed, it led into the common hepatic duct. The papilla of Vater could not be found. The fistula between the hepatic duct and the stomach was com-

pletely obliterated. Instead there developed a communication between the hepatic duct and the duodenum.

Cahen believes that the tube had wandered away from the stomach after the catgut sutures had absorbed. The free end of the tube, according to him now impinged upon the duodenal wall and caused a decubitus ulcer. After the expulsion of the tube from the stomach the oblique canal in the latter became obliterated and the bile found its way into duodenum through the ulcerated portion. The newly formed adhesions pulled up the duodenum close to the liver hilus. When we recall Lahey's experience with formation of spontaneous internal biliary fistulas, we feel that Cahen's exploration is perhaps unnecessarily complicated. The essential feature is the presence of adhesions which brought the duodenum up to the mouth of the hepatic duct. The formation of communication between the two was perhaps nothing more than the formation of a spontaneous internal biliary fistula when the anastomosis between the duct and the stomach became obliterated. Adhesions have approximated the common hepatic duct and duodenum and the effect of bile completed the formation of an anastomosis between the two. In other words, nature had apparently performed a sort of hepatocoduodenostomy. Cahen does not believe that epithelization of the new channel takes place. He feels that nature plays an important part in the reconstruction by pulling up the duodenum to the hilus of the liver through newly formed adhesions thereby materially shortening the gap. No histological study was made.

The second case reported was that of Desplas.

He resected the hepatic duct for a malignant tumor of pancreatic origin. He inserted a Pezzar rubber catheter into the left hepatic without suturing it there. The distal end was introduced into the stomach, thus leaving from 8 to 10 centimeters of the tube running exposed in the peritoneal cavity. The exposed tube was covered by omentum. The patient recovered from jaundice and gained in weight. Later cachexia and ascites developed because of the presence of a malignant growth but jaundice did not return. Exitus took place 152 days after the operation.

Postmortem examination revealed a large tumor

of the head of the pancreas. The duodeno-pylorus was adherent to the left biliary pedicle. Stomach, liver, pancreas and duodenum were removed *en masse*. When the stomach was opened the tube was found to have passed as far down as the third portion of the duodenum. Between the duodeno-pylorus and the hilus of the liver there had formed a fibrous channel which was found to be intact and which permitted the passage of a sound. Apparently, there had formed about the Pezzar catheter a fibrous channel establishing an anastomosis between the liver and the stomach. The stomach and the duodenum were pulled up by adhesions and adhered to the liver hilus.

Histological examination of the new hepatogastric channel revealed that its proximal portion toward the hepatic pedicle possessed an epithelial lining of the type of hepatic mucosa. The distal portion of the duct was lined by a mucosa containing Brunner's glands and resembling that of duodenal mucosa. One-half of a centimeter of its middle portion contained no epithelial lining. It was made up of connective tissue fibers only. In the liver were found biliary abscesses.

In the discussion Gernez related necropsy findings in his own case (third case).

He operated on a man 60 years of age because of chronic jaundice. The gall bladder, cystic and the common ducts were replaced by fibrous tissue up to the common hepatic. Gernez inserted one end of the tube into the common hepatic duct the other into the stomach. The patient was in good health for 4½ years, at the end of which time he developed jaundice and died. Postmortem examination revealed obliteration of the midportion of the new channel. No histological examination was made.

The findings in the 3 cases suggest that the most important factor in the favorable outcome is played by nature itself. I have again reference to the formation of adhesions which result in pulling up of duodenum and stomach to the liver. This materially shortens the gap between the two bringing about a sort of hepatocoduodenostomy or choledochoduodenostomy or gastrostomy.

In only 1 case that of Desplas was a histological examination made. When one considers that the new channel was relatively short, the fact that its midportion was still devoid of epithelium 152 days after the operation does not suggest much regenerative power on the part of the latter. It would be difficult under the circumstances to say whether the epithelium in its upper and lower portions was newly formed or old. In the third case stenosis took place in the mid

portion of the new channel probably because it contained as in the case of Desplas connective tissue only

EXPERIMENTAL DATA

Sullivan (39 60) was undoubtedly the first in 1908 to perform in dogs the operation of uniting the common hepatic duct with duodenum by means of a buried rubber tube. His technique was as follows the common duct was cut across and a rubber tube was introduced into and up into the common hepatic duct and secured there by a suture on either side. The tube ran freely in the peritoneal cavity down to the upper border of the first portion of duodenum to which it was secured after the manner of Witzel's gastrostomy. Its end was introduced into the lumen of duodenum through a stab wound. The exposed tube was covered by an omental flap. He had operated in this manner upon 8 dogs without a single mortality. Although he had 8 available animals Sullivan subjected only 1 to a histological examination. This specimen was removed from a dog 10 days after the operation. His pathologist reported that the mucosa had grown upward from the duodenum and downward from the duct into the new formed tube. In its middle portion its walls are made up of peritoneal tissue.

Enderlen and Usti in 1911 produced defects in the gall bladders of rabbits and dogs and covered them with an omental graft. After 19 days the graft was found to be completely covered by new epithelium. About this time formation of glands was noted. The new epithelium was of a low cuboidal type but later became high cylindrical. The graft showed connective tissue proliferation which later underwent contracture.

Arnsperger and Kimura, of Wilms clinic, performed in 1912 the Sullivan operation in dogs. The tube usually passed about the thirty fifth day. Their animals died of peritonitis caused in their opinion by premature passage of the tube bile leakage, or perforation of the new duct at a point at which the omental flap was not well applied. All of the animals developed a stenosis at the point where the new channel entered the duodenum. Only 1 dog did not develop obstruction and jaundice

and this one died of pneumonia 30 days after the operation. They state that epithelialization did take place in some of the dogs, but do not mention any histological study. Gross inspection is obviously no reliable criterion.

In 1913 C B Davis and Dean Lewis made in dogs tubes of fascia taken from the sheath of the rectus muscle, and placed them about a defect in the common duct. In their first series 3 dogs survived 2 months. In a dog which survived 65 days stenosis took place at the duodenal end. The fascia remained alive in all cases. The histological report was to come later.

In 1918 Horsley attempted in dogs to substitute an everted external jugular vein for the common bile duct. The vein was stitched to the common hepatic, and the distal end was introduced into the duodenum by a sort of modified Witzel technique. He operated in this manner on 16 dogs. Most of the animals died of bile leakage at the suture line of the duct with the vein. Horsley considered the final results unsatisfactory and invoked a biological law to explain the contracture which took place in every case in which the dog survived the operation. The irritating effect of bile upon tissues not adapted to it caused inflammation with subsequent contracture. In spite of the discouraging results Horsley states, "That epithelium does grow at least over a portion of the reconstructed duct is shown in one section (23 days old). Columnar epithelium has grown a considerable distance over on the transplanted vein."

Somewhat more ambitious experiments accompanied by photomicrographs of histological sections were reported by Seullberger and Poellwein in 1926. These authors made three groups of experiments. In group 1 anterior defects in the choledochus covered by omentum they did not observe the slightest trace of epithelial regeneration in specimens 39 and 113 days old. The defects were not very large. In groups 2 and 3 choledochogastrostomies and choledochoduodenostomies *a la* Sullivan the newly formed ducts invariably became stenosed. No epithelialization was noted in the granulation tube even in specimens 100 days old.

Latten (39 40) believed that diverting the

flow of bile away from the common duct would favor healing of defects. He performed a series of experiments in dogs in which a metallic tube was introduced into the common duct through a small incision in the gall bladder. The tube could be removed at a later date by means of a string attached to it. By means of two tight ligatures a portion of the common duct was caused to undergo necrosis. This area was covered by an omental graft. The tube was removed from 3 weeks to 2 months later. The animals were sacrificed 3 to 4 months after the operation. In 6 of 7 dogs the regenerated duct exhibited a complete mucosal lining. In spite of it all of the ducts exhibited marked narrowing with dilatation above.

In a second series Lattin utilized the trachea of a guinea pig, of a lark, and a pigeon quill to bridge a 1 centimeter defect in the common duct of a dog. In 7 experiments the prosthesis passed of its own will and epithelization took place.

Musenecck's experiments published in 1926 represent a distinct advance. He operated on a larger number of dogs than any one before him. Musenecck emphasized the fact that the duodenum was found in each postmortem examination to be plastered against the liver. Curiously enough this phenomenon emphasized by Cahen in a clinical report in 1913 was not observed in animal experiments until the reports of Musenecck.

Musenecck operated on 53 dogs. In a group of 25 he attempted vein transplantation. The results were so poor as not to justify an attempt at analysis.

In another group of 28 dogs he made cuff excisions in 9 and in the rest either a typical or a modified Sullivan operation. His mortality was high. In a group of 7 Sullivan operations 6 died of peritonitis between the third and ninth postoperative days. Of 28 animals 26 developed stenosis, and in these there was not found a trace of epithelization. In only 2 dogs did there not develop a stenosis. Musenecck was much impressed by the fact that in these two the tubes remained *in situ*. They showed no infection of bile. The duodenum as in the rest of his animals was plastered up against the liver. The new ducts were

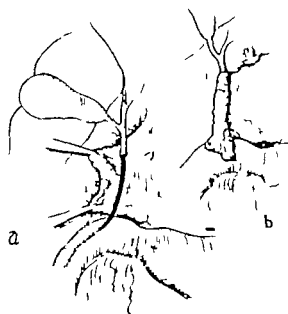


Fig. 1. a and b. Technique of application of tube.

therefore quite short, about 2 centimeters in length. They were lined by epithelium, but whether this was new or old epithelium brought together, the author did not feel certain. He was not sure that one was justified in speaking of a 'new duct'. So long as the tube remained *in situ*, the danger of stenosis was lessened. He would therefore advise that the tube be made to stay in as long as possible.

PERSONAL EXPERIMENTS

A comparison of results obtained in reconstructive work on the bile ducts in the two fields, the clinical and the experimental, reveals that they were much inferior in the latter. The reason assigned was the smallness and the delicacy of these structures in the experimental animal. While this is true, it may be pointed out that while the surgeon is frequently called upon to operate in the presence of baffling adhesions, cholemic bleeding, and inflammatory states, the experimenter is always operating in a clean field and upon normal structures. Schrager and Ivy have correctly pointed out that a special knowledge of conditions as they obtain in a dog and an adoption of a suitable technique are just as essential to success here as elsewhere.

The number of successful experiments in any one report was too small to justify drawing conclusions therefrom. Frequently post



Fig. 2. Transverse section, dog 8.



Fig. 3. Transverse section, dog 21.

mortem examinations lacked accuracy and only in a few instances were there histological examinations made. Sullivan subjected to a histological study only one specimen although he had 8 surviving animals. For some reason he had the specimen removed on the tenth postoperative day—a period entirely too brief to test the regenerative capacity of epithelium. The pathologist's report is ambiguous on the crucial point. He states that the midportion of the new duct consisted of peritoneal tissues whereas the question in point is whether or not this tube of peritoneal tissue (omentum) was lined by epithelium.

Horsley submitted one new duct (23 dogs) to a histological study and declared that it was at least partly lined by new columnar epithelium. Young epithelium is cuboidal columnar epithelium suggests mature cells.

Seulberger and Poellwein do not state the exact number but seem to have made a histological study of several specimens. These authors have not observed any effort on the part of the epithelium to proliferate.

Musenecck operated on more dogs than any experimenter in the field before him. His postmortem observations were characterized by greater accuracy. He did not miss the importance of adhesions and reports that the duodenum in every case was adhered to the liver. On the other hand Musenecck, together with the rest of the experimenters apparently never observed a duodenal ulcer though he had an unusually large number of postopera-

tive stenoses of the bile duct. In my animals the incidence of duodenal ulceration among those exhibiting varying degrees of bile duct stenosis was very high.

An attempt was made in my own work to obtain a sufficiently large number of successful experiments to justify drawing conclusions therefrom. By a successful experiment I mean one in which the animal survived a typical operation was allowed to live a suitable period of time and was sacrificed at will. A careful postmortem examination completed each successful experiment. I have operated on 135 dogs and can report on 28 completed experiments.

The incidence of peritonitis, of death from bile leakage of ascending infection leading to liver abscesses was very high in the beginning of my work. Dogs are undoubtedly very sensitive to spilling of bile in the peritoneal cavity. A number of them died of bile leakage within the first 24 or 48 hours without developing signs of peritonitis. As the work progressed the ducts became considerably larger and the postoperative mortality was reduced to an insignificant minimum. The use of nembutal anesthetic (Abbott) adopted in the later period of my work proved an important factor in the reduction of anesthetic fatalities.

Experiments were planned so as to throw light upon the ability of ductal epithelium to proliferate and fill in large longitudinal defects (Group I) small longitudinal defects (Group II) as well as to grow along a prosthesis and fill in a transverse gap (Groups III and IV).



Fig. 4. Transverse section dog 1

TECHNIQUE

Group I A rubber tube French catheter No. 8 or No. 10 was introduced into the common bile duct through a small incision. The tube was passed upward and was fixed there by tying a ligature about the duct and the tube or by placing a suture on either side of the duct so as to include in it the tube and the duct. The lower end of the tube was made to pass along the duct through the papilla of Vater into the lumen of duodenum. A variable amount of the duct wall was now destroyed. Since it was not possible to measure accurately the width of the defect because the tube forced the edges of the wound apart an attempt was made to estimate the width of the defect in terms of percentages of the circumference of the duct. The length could be readily measured. The defect was covered by a flap of the gastrophatic omentum pulled under the posterior aspect of the bile duct and laid over the defect. A few interrupted sutures were employed to fix the flap in place so as to make a complete omental tube about the defect (Fig. 1 a and b). This step was found to be quite useful later in recognizing the reconstructed duct in postmortem examination. The adherent omental flap indicated the area (Figs. 1 and 2). The length of the defect in the group was usually from just below the cystic duct down to the superior border of duodenum almost the entire length of the supraduodenal portion of the duct. The width of the defect was from 50 to 70 per cent of the circumference of the duct in several instances only a narrow posterior strip of the duct wall being left.

Group II Essentially the same technique was employed, the defect varying from that



Fig. 5. Transverse section dog 24

of a mere longitudinal slit in the anterior wall to not more than 40 per cent of the circumference of the duct.

Group III This group was carried out according to Sullivan's technique. A rubber tube was introduced into the common bile duct and was fixed there just below the cystic duct by a suture made to pass through the tube and the duct on each side of the duct. The duct was resected below the sutures and the lower stump at the border of duodenum was ligated with silk. The tube running freely exposed in the peritoneal cavity was laid upon the superior anterior wall of the first part of the duodenum to which it was now fixed for about a distance of $1\frac{1}{2}$ to 2 centimeters after the manner of Witzel's gastrostomy technique. The lower end of the tube was introduced into the lumen of the bowel through a stab. Omental tissue drawn from the lesser omentum the greater omentum or both was used to make a tubular investment for the exposed tube (Fig. 1 a and b).

Group IV Cuff excision. A rubber tube was introduced as in the previous group. This tube was secured just below the cystic duct by a suture on either side of it. Another pair of sutures fixed it to the duct just above the superior border of duodenum. The intervening duct was cut away. The gap was covered by an omental flap.

ANALYSIS OF RESULTS

Results were analyzed in the light of the following points:

1. Occurrence of ascending infection



Fig. 6 High power photomicrograph, dog 5.



Fig. 8. Photomicrographic section showing normal tissue.

- 2 Incidence of stenosis and its relation to the ascending infection
 - 3 Influence of tube remaining *in situ* on the occurrence of ascending infection
 - 4 Epithelial regeneration in four groups
 - 5 Relation of inflammation in wall of reconstructed duct to epithelial regeneration
 - 6 Relation of stenosis to epithelial regeneration
 - 7 Adhesions of duodenum to the liver and its effect upon the length of the new duct
- Total number of dogs operated on was 130



Fig. 7 Adhesion of duodenum to under surface of liver

The number of successful experiments was 28 Group I—10 dogs Group II—6 dogs Group III—10 dogs and Group IV—2 dogs.

Of a total of 28 dogs, 5 did not develop an ascending infection. Eight exhibited a high grade of infection and in 15 it was mild. The severe grades of ascending infection were characterized either by acute lesions, such as purulent cholecystitis, purulent cholangitis with multiple liver abscesses or by more chronic lesions, such as a thickened gall bladder or a hobnailed liver.

The milder grades of ascending infection manifested themselves by the presence of adhesions between the gall bladder and the diaphragm the stomach duodenum etc. The gall bladder was frequently enlarged its walls thickened and the characteristic slate blue color changed to a whitish or greyish. It was interesting to note in these cases the presence of milky radiating scars on the surface of the liver so called subcapsular scars considered characteristic of a gall bladder infection in man. They were most prominent over that area of liver overlying the gall bladder. These subcapsular scars were seen only at a post mortem examination never at operation.

When we examine the relation of ascending infection to stenosis, we find that all of the animals exhibiting stenosis likewise exhibited an ascending infection. In Group I dogs 3, 8 and 24 did not develop a stenosis of the reconstructed duct. Dogs 3 and 24 did not exhibit any evidence of an ascending infection and

dog 8 a very mild one. In Group II dogs 6, 14, and 20 did not develop duct stenosis and in dogs 14 and 20 no ascending infection was evident. When we examine Group III, we find that while dogs 16, 21, and 22 had no stenosis only dog 16 did not exhibit signs of an ascending infection. Dog 22 had a mild and dog 21 a severe infection in the absence of a stenosis. From this it is apparent that while stenosis never failed to be associated with an ascending infection, its absence did not save dogs 8, 19, and 22 from a mild and dogs 6 and 21 from a severe infection. Furthermore in dogs 19, 21, and 22 the tube did not pass. The contention of Musenczek that the presence of the tube in the duct is a safeguard against an ascending infection because it prevents stenosis is therefore incorrect. While the tube prevented stenosis it was not able to prevent an ascending infection in dogs 19, 21, and 22. It may be assumed that the responsible factor in the 5 dogs without stenosis was interference with the closing mechanism of the sphincter of Oddi.

The question of epithelial regeneration. That ductal epithelium possesses a capacity for regeneration could be safely assumed *a priori* on purely biological considerations. It is well known that epithelial liver cells as well as epithelial cells lining intrahepatic ductus biliferi possess a high degree of regenerative power. However it is likewise known that under certain conditions these cells perish and fail to regenerate. Our query therefore, should be not so much can the ductal epithelium regenerate but rather, can it regenerate under certain conditions?

In Group I there were extensive defects running almost the entire length of the supraduodenal portion of the choledochus and involving from 50 to 70 per cent of the circumference of the duct. Of 10 dogs 4 showed complete epithelial regeneration, 6 none.

In Group II, with small defects running from a longitudinal slit to defects not larger than 40 per cent of the circumference, all of the ducts healed by epithelial proliferation.

The Sullivan group consisting of 10 dogs, did not exhibit, in a single instance, any epithelial ingrowth in the new channel—thus despite the fact that the new channel in each

was much shorter than the reconstructed duct at the time of operation (Fig. 3).

In Group IV one dog showed no epithelial regeneration and the other showed a markedly hypertrophic epithelial lining. However I believe it to be old epithelium. The duodenum was adherent to the liver shortening up the original duct to one half its original length. The amount of duct resected was 2 centimeters. It is easy to see that the stumps of the resected duct became approximated in that way. Furthermore young recently regenerated epithelium does not exhibit such marked papillary evagination as did this one.

If we enquire further into the question of why in Group I 4 ducts displayed complete epithelial regeneration while in 6 there was none we find a ready answer in the histological picture of these ducts.

Dog 3 with a large defect in the common bile duct had an uneventful recovery. The animal never exhibited jaundice its nutrition was good and general health perfectly normal. It was sacrificed exactly one year after the operation. At postmortem examination the peritoneum was found to be normal. The first portion of the duodenum was adherent to the liver. Liver, stomach, and duodenum were removed together. The duodenum was slit open on its mesenteric side. The tube was not to be seen. The papilla was visualized and a sound introduced into it passed upward into the hilus of the liver without meeting any obstruction. The common bile duct appeared smooth somewhat larger than normal, and whitish in appearance. All of the supraduodenal portion of the duct was removed for histological study. Transverse serial sections were made and were stained with hematoxylin and eosin. In all of the sections the epithelial regeneration was practically complete. The original epithelium was readily recognized by its marked papillary evagination and a marked tendency to formation of parietal sacculi. The new epithelium was rather poorly developed. There was no evidence of inflammatory reaction in the wall of the regenerated duct. Gall bladder sections and liver sections appeared normal.

Dog 8 The duct was very fine. After introduction into it of a ureteral catheter No. 6, all that was left of the duct was a strip of the posterior wall. The defect was covered by an omental flap. The work was considered unsatisfactory. The dog however remained in good condition and was sacrificed 106 days later. On postmortem examination the peritoneum was found to be normal. The gall bladder was pinkish-grey. Its fundus was attached to the dome of the diaphragm by a broad adhesion. The first portion of the duodenum was adherent to the inferior aspect of the right lobe of the liver. On the surface

of the liver were seen milky radiating subcapsular scars. Liver, stomach, and duodenum were removed *en masse* and laid on the table for more detailed study. The duodenum was opened on its mesenteric side. Pressure on the gall bladder caused thick bile to flow from the papilla. A probe passed up without encountering any obstruction. The duct appeared somewhat larger than normal felt thicker and presented a smooth glistening appearance. Transverse sections of the duct showed complete epithelial regeneration. The epithelium was quite normal. It displayed papillary evaginations and parietal sacculi (Fig. 2). Comparison with a normal duct of a dog (Fig. 4) demonstrates that there is no inflammatory reaction in the wall of the regenerated duct.

As a contrast to dogs 3 and 8 I shall present the history of dog 1.

Dog 1. The same operation was performed here as in dogs 3 and 8. Three weeks after the operation the animal exhibited signs of biliary obstruction, but these had disappeared and the animal remained in a fair state of nutrition. He was sacrificed 106 days after the operation. Postmortem examination showed the following. The liver was much enlarged. There were firm adhesions between the liver, duodenum and stomach. All visible extrahepatic ducts were tremendously enlarged. Liver, stomach, and duodenum were removed together and the duodenum and stomach were slit open. Pressure on the fundus of the gall bladder caused a watery viscous fluid to exude from the papilla. A probe passed up the papilla became arrested just above the superior border of the duodenum. The duct above the constriction was tremendously enlarged. The point of obstruction corresponded to the site of the lower ligature tied about the duct and the tube. The supraduodenal portion of the duct was removed for histological study. Transverse sections showed the lumen of the duct for the greater part, at least 70 per cent of it, devoid of any epithelial lining. Whatever epithelium there was exhibited poor development, total absence of papillary evaginations and of gland formation. The duct wall itself was tremendously hypertrophied. It consisted of enormous amounts of connective tissue. Here and there were to be seen areas of marked infiltration with polymorphonuclear leucocytes (Fig. 4).

Dog 2. In this animal there was not a trace of epithelium. The wall was of extraordinary thickness.

The same histological picture was found in all 6 animals which did not show any epithelial regeneration. The ducts which healed by epithelial proliferation exhibited in all four instances a wall of approximately the thickness of a normal duct. Conclusion may be drawn from Groups I and II that ductal epithelium is capable of growing and filling in small as well as extensive longitudinal defects, pro-

vided that its blood supply is not compromised by an excessive inflammatory process. Excessive reaction with its superabundant connective tissue undergoes a later contracture with the development of a stenosis. There was no instance of epithelial regeneration in the presence of a stenosis in all of the series save one. This exception was dog 13 in Group IV. However as pointed out before, we were dealing here most likely with old epithelium brought together rather than with new epithelium.

Epithelial growth is influenced more by an adequate blood supply than by the extent of the defect. This was strikingly demonstrated in dogs 24 and 25 of Group I. In dog 24 the defect amounted to 1.7 centimeters in length by 70 per cent of the circumference. It was sacrificed 95 days later. There was no evidence of an ascending infection, or of stenosis. Epithelial regeneration was complete. The duct wall showed no inflammatory reaction (Fig. 5 dog 24).

Dog 25. The defect was smaller than in dog 24. It amounted to 1.5 centimeters in length by 50 per cent of the circumference. It was sacrificed 81 days after operation. Mild stenosis of the duct was present. There were no signs of a mild ascending infection, such as a thickened gall bladder subcapsular scars on the liver surface, and a hobnailed appearance of the liver. A partly healed gastric ulcer was found. Histological sections demonstrated that epithelium was absent in many parts, and that wherever present, it was poorly developed. The duct wall was abnormally thick and consisted of bundles of connective tissue. These were seen to surround epithelial glands. One could easily see how later contracture would choke the epithelial elements (Fig. 6).

In the Sullivan group of 10 dogs there was not a single instance of epithelial proliferation in the new channel. The same was true of Group IV. Therefore it is evident that epithelium will not grow along a prosthesis to fill a transverse gap. How can we explain the successful results of Jenckel, Verhoogen and Wilms? Verhoogen's case was repeated in dogs 4 and 13. I feel that I am justified in rejecting the theory of epithelial proliferation along the prosthesis on the basis of post mortem evidence of Desplas and on the basis of my results with the Sullivan group. Explanation must be sought in the formation of

adhesions between the duodenum, pylorus, and the liver. The effect of this phenomenon is obvious. It shortens materially the gap to be bridged. It is easy to see that in Verhoogen's case the stumps of the duct were brought together in just this manner. It would be difficult, if not impossible to explain the *modus operandi* of repair except on this basis. Cahen was first to call attention to the rôle played by these adhesions in the description of the postmortem examination of his patient, in 1913. Museneck emphasized its occurrence in experimental work. In my own material it took place in all but 1 animal (dog 24). The length of the duct in this dog appeared unusual. I have made an attempt to measure the length of the choledochus at the time of operation and again at postmortem but this was impossible because of adhesions and altered relations. It would however be no exaggeration to state that the new ducts were markedly shortened. In the dog the duodenum is freely movable. Furthermore, in my work it was necessary to hold and exert some pull upon the first portion of the duodenum in order to expose the free edge of the hepatoduodenal ligament. Mechanical trauma with perhaps some spilling of bile furnished sufficient irritation to produce adhesions. While in reality a mild pathological complication it no doubt played a most favorable part in the outcome of successful cases (Fig. 7).

Duodenal and gastric ulceration in dogs with stenosis of the common bile duct. That the exclusion of bile from the intestine may lead to development of duodenal or gastric ulcers has been recently pointed out by Kapanow, Kim and Ivy, Berg and Jobling, and others. I was not familiar with this fact until an acute perforation of a duodenal ulcer in dog 5 forcibly called my attention to it. Observations on this point were made in 20 animals. Nine developed stenosis and of these 9, 7 had ulcers. Duodenal ulcer occurred alone four times, gastric alone twice, duodenal and gastric once. There was one perforation. The incidence of occurrence was 78 per cent. All of the animals exhibited more or less hepatitis.

The cause of ulceration may be at least in part due to interference with the process of alkalization of acid chyme by the bile.

There is evidence to believe that hepatitis may play an important part in the causation of these ulcers.

CONCLUSIONS

1. Epithelium lining the extrahepatic bile ducts is capable of regeneration under favorable conditions.

2. Small longitudinal defects will heal readily by epithelial regeneration, a fact familiar to the clinical surgeon and borne out by the experiments in Group II.

3. Longitudinal defects, even if extensive may regenerate under favorable conditions, namely, in the absence of marked inflammatory reaction in its walls as demonstrated by Group I.

4. Ductal epithelium is not capable of growing along a prosthesis and lining a gap as was demonstrated by Groups III and IV.

5. Obstruction to the flow of bile invariably leads to an ascending infection. The presence of a tube in the bile duct, even with the absence of a stenosis, leads to infection presumably by interfering with the mechanism of the sphincter of Oddi.

6. Diversion in dogs of bile from the duodenum results in a high percentage of duodenal and gastric ulcerations invariably accompanied by a hepatitis.

7. Dogs die in from 24 to 48 hours from the effect of spilling bile into the peritoneal cavity without signs of peritonitis.

8. Omental covering is the ideal safeguard against bile leakage and infection.

9. Excessive inflammatory reaction at the site of repair is prejudicial to epithelial growth. (The use of absorbable suture material and omission of drain would tend to minimize such reaction.)

10. The Jenckel-Sullivan or Wilms-Brewer operation can be regarded only as a measure of necessity justified under certain desperate conditions rather than as operation of choice. Formation of adhesions with their subsequent contracture and pulling up of the duodenum to the porta hepatis is the more plausible explanation of the *modus operandi* of healing in an occasional successful case than the problematic growth of ductal epithelium along a prosthesis or new channel.

SUMMARY

Causes leading to stenosis of the extra hepatic bile ducts were discussed and clinical evidence regarding their regenerative capacity educed. From the analysis of the results of various methods of reconstruction it is apparent that the stumbling block to success is the question of adequate blood supply to the new channel. That is particularly true of the method of fistula implantation and also of flap methods. The method of bridging a gap with a rubber tube was given particular consideration. Clinical evidence regarding its efficacy was found to be contradictory. Adherents of the method concluded that success was explainable on the basis of extraordinary regenerative capacity of ductal epithelium. The epithelium they believed grew along the prosthesis and lined the new channel.

The question of regenerative capacity of ductal epithelium was studied experimentally. It was found that epithelium will proliferate and fill longitudinal defects even if extensive provided there be no excessive inflammatory reaction at the site of repair. The question of blood supply to the epithelium was again found to be the determining factor. It was found that epithelium will not grow along a tube and will not regenerate a transverse gap. This experience coincides with the postmortem evidence of clinical cases.

Importance of adhesions as a factor in favorable outcome was emphasized. This idea receives its support from the observations of Cahen Lahey Musenbeck and my own experimental work. There is no one satisfactory method at the present time of dealing successfully with cases of extensive bile duct obliteration in which direct anastomosis is not possible.

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CARCINOMA OF THE OESOPHAGUS¹

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THE problems presented by tumors of the oesophagus have engaged the attention of many capable surgeons pathologists internists and endoscopists during the past 30 years. The radiologist being concerned with the diagnostic and the treatment phases of the problem has had a twofold interest in the disease. This widespread interest has led to the accumulation of considerable literature on the subject.

Much original thought, experimentation and imagination have gone into the development of the many varied forms of treatment which have been advocated at one time or another for the cure of cancer of the oesophagus. Noteworthy among these methods was the advent of radium as an intra-oesophageal method of irradiation. This method was first proposed in 1904 and soon the literature was quite flooded with descriptions of new apparatus, new dosages, new filters and new methods for accurately locating the radium in the oesophagus. This period begun so hopefully was not however followed by reports of cures or even good palliative results and the method fell somewhat into disfavor.

A great deal of attention had been directed toward the development of a procedure for radical removal of carcinoma located in the oesophagus. In several of the larger European clinics some significant results had been obtained in the removal of the cervical and intra abdominal portions of the oesophagus for carcinoma. The first successful intra thoracic oesophagectomy was accomplished in this country by Torek in 1913. With this success oesophageal surgery was thought to have reached a point where it could be called the answer to the treatment problem. Unfortunately surgery has not fulfilled its early promise. Such a general lack of success would lead one to suspect that those who have advocated these various methods of treatment have been unjustifiably optimistic.

A careful study of the clinical course of the disease, the anatomy of the organ involved

and the postmortem material available will show that patients with cancer of the oesophagus should be given palliative treatment as a routine measure and that only in the very unusual early case should intra-oesophageal irradiation or radical surgery be attempted. The cured case will be a medical curiosity.

The material for this report has been taken from the Memorial Hospital records accumulated during the 13 year period between 1918 and 1931. Five hundred and six (506) patients with carcinoma of the oesophagus were admitted to the hospital and of this number there were 267 patients with positive biopsy diagnoses. For the past several years all patients have had biopsies removed for diagnosis. Previously this was considered an unnecessary risk, and for this reason, biopsies were seldom taken from the early patients. The entire material of 506 cases has been summarized in this report, but the statistical portion is based on a study of only those cases with positive microscopical sections. To include the cases without biopsy would be quite justifiable but would not appreciably alter the statistics and might lead to some criticism as to the accuracy of the figures.

Twenty nine patients suffering from oesophageal obstruction thought to be cancer were admitted and later their obstruction was proved to be due to such benign causes as spasm, syphilis, non specific ulcer acid or alkali burns and idiopathic stenosis. Most of these patients recovered under appropriate dilatation measures.

An intimate knowledge of the anatomy of the oesophagus is necessary in order to understand the dangers and difficulties encountered in the treatment of cancer in this organ. The oesophagus is a thin walled tube about 25 centimeters in length, developed from the foregut. It differs from the other portions of the intestinal tract in that it lacks an outer serosal covering, a distinct surgical disadvantage. The oesophagus is richly supplied with lymphatics in the submucosal and muscular coats,

thus providing a submucous pathway for the dissemination of cancer. Mucus forming glands are found throughout the oesophagus and undoubtedly give rise to the adenocarcinomata which occur in this organ. The oesophagus is surrounded throughout its length by important and vital structures (Fig. 1) which are invaded early in the course of oesophageal cancer.

GROSS PATHOLOGICAL ANATOMY

Gross examination of a number of oesophageal carcinoma specimens demonstrates three definite types. First there is the bulky, polypoid projecting, or vegetative type which usually grows into the lumen of the oesophagus causing obstructive symptoms at a relatively early stage (Fig. 2). Second, there is the shallow ulcerating type causing early symptoms of mediastinal involvement such as pain and backache (Fig. 3). Metastases and obstructive symptoms may be absent. This type tends to perforate the musculature of the oesophagus early and to invade the aorta, bronchi or trachea. Perforation into one of these vital structures causes death, most often by sudden hemorrhage due to the perforation of the aorta or other large vessels (Carr, Polson and McIntosh Heitzmann). Third, there is the hard, infiltrating scirrhous type which invades the oesophageal wall, and which may encircle the lumen causing fixation of the walls and producing symptoms of obstruction. It may be superficially ulcerated (Fig. 4). The extension of the disease by way of the submucous lymphatics is shown in Figure 5. Here we find an outcropping of tumor tissue several centimeters above the primary growth.

Oesophageal growths are usually divided into another three groups according to their location in the upper, middle or lower third of the oesophagus. Recently it has become the custom to locate the lesion by its relation to the various anatomical constrictions of the oesophagus. This method is more accurate than the former. Table I shows the relative frequency of cancer of the oesophagus at the three levels.

The most plausible reason for the relatively high frequency at the lower third (about 50 per cent) is the increased irritation due to the

TABLE I—DISTRIBUTION OF GROWTHS

Authority	Cases reported	Upper 1/3		Middle 1/3		Lower 1/3	
		Cases	Per cent	Cases	Per cent	Cases	Per cent
Kraus	837	158	18.4	322	38.3	357	42.3
Jacoway and Green	525	30	5.7	127	24.2	368	69.9
Memorial Hospital series	245	46	18.8	67	27.3	132	53.8

slowing of hot liquids at the diaphragmatic constriction and to the frequent presence of chronic spasm in this location.

MICROPATHOLOGY

In the Memorial Hospital series of 267 cases there were 243 squamous cell lesions, 19 adenocarcinomata and 5 of the transitional cell type. The adenocarcinomata were all located in the lower third of the oesophagus. Guisecz reported a series of 1,413 cases, five sixths of which were squamous cell carcinomata and one sixth adenocarcinomata. He did not once encounter a sarcoma. Jackson reported 671 cases of which 316 were adenocarcinomata all located in the lower third of the oesophagus, 2 lymphosarcomata, 2 round cell carcinomata and the remainder, 337 cases squamous cell carcinomata.

With 267 positive biopsies it was found that the material was suitable for grading in 227 cases. This work was done largely by Dr F. W. Stewart. Table II shows the relative frequency of the different grades and the number of cases which were diagnosed as histologically susceptible to radiation. In this series it is seen that there were only 39 cases (12.7 per cent) in the grade 3 group, 14 (6.1 per cent) of which were reported as probably radiation sensitive. Only 30 of the cases (13.2 per cent) in the grade 2 group were probably radiation sensitive. About 18 per cent of the carcinomata of the oesophagus are radiation sensitive. This evidence does not agree with Guisecz's impression that oesophageal cancers are as a rule susceptible to radiation. There were no cases in the grade 4 group. Figure 6 shows photomicrographs of the three grades of carcinoma which occur in the oesophagus.

Broders and Vinson reported 220 cases with 90 per cent in groups 3 and 4 and no grade 1

TABLE II.—RELATIVE FREQUENCY OF GRADES

	Cases	Re-Section relative
Grade 1	15	0
Grade 2	148	30
Grade 3	39	14
Adenocarcinoma	10	
Transitional cell	6	
Totals	227	44

cases. In the Memorial Hospital series 83 per cent of the cases fell in the groups 2 and 3.

AUTOPSY FINDINGS

Most of our cases are hospitalized for a short time only. For this reason the autopsy material is limited to 27 cases. Thirteen cases (48 per cent) coming to postmortem showed no evidence of metastasis. It must be borne in mind however that a careful autopsy does not always demonstrate the presence of early metastatic deposits. There was gross lymph node involvement in 12 (44 per cent) of the 27 cases (Fig 7). In 7 cases (26 per cent) there was extension to or actual rupture into the trachea or bronchus. In 2 cases (7 per cent) the disease ruptured into the aorta causing sudden fatal hemorrhage. Pneumonia was a contributory cause of death in 13 cases (48 per cent). 12 were bronchopneumonias, and 1 was lobar in type. In 4 cases hemorrhage was the cause of death. Other causes were peritonitis 3 cases starvation asphyxia cardiovascular disease generalized carcinoma toxæ, septicæmia, and diarrhoea, each 1 case. In one case the cause of death was not determined due to a limited autopsy permit.

ETIOLOGY

It is not possible to give exact etiological data. However it is now quite generally believed that there are certain definite factors which predispose to oesophageal new-growths. In the oral cavity it has been shown that broken irregular or sharply worn teeth ill fitting plates, leucoplakia excessive pipe smoking syphilis and intra-oral sepsis are definitely irritating factors in the causation of intra-oral carcinoma. Similar factors prepare the oesophageal mucous membrane for cancerous changes. Badly kept teeth intra-oral sepsis, and ill fitting plates tend to cause hasty and incomplete mastication which makes

it necessary for the oesophagus to handle masses of food which are large and hard. A large hard bolus of food causes a certain amount of trauma and inflammation of the oesophageal mucous membrane. The passage downward of such a bolus of food would be slowest at the point of anatomical constriction and the resulting trauma would be greatest at these points. This trauma causes irritation which may lead to spasm, and with it further slowing of the food bolus and later stagnation, oesophagitis, ulceration and possibly tumor.

Thermal irritation is probably the most constant factor predisposing to carcinoma of the oesophagus. The frequent drinking of copious amounts of excessively hot tea is a history frequently obtained from the Russian patient suffering from cancer of the oesophagus. This fact is especially significant when it is seen that 46 per cent of the foreign patients in our series were born in Russia. There were more Russians than native born patients (Fig 8). In China, cancer of the oesophagus is very uncommon among the women. This is said to be due to the fact that they eat after the men have finished and the rice is not so hot. The women of Scotland drink excessively hot tea and Turner has reported that cancer of the oesophagus is more common with them than it is among the men.

Leucoplakia of the oesophagus is being recognized more frequently due to the increasing popularity of the oesophagoscope. It is a very common condition. Schaer found it to be present in 60 per cent of 200 non-cancerous cases coming to autopsy. Clinically and pathologically the process is the same as that seen in the oral cavity (Sharp) where it is a definite etiological factor.

Gulrez who has had a very extensive experience with oesophageal cancer thinks the excessive use of alcohol spiced food and tobacco are factors in many of his cases. He has noted also that the onset of cancer of the oesophagus is often definitely attributed by the patient to some particular mental or physical shock. He observed an increase in the incidence of cancer of the oesophagus in young adults following the World War and thought the following sequence of events had taken place first an emotional upset then an oesophageal cancer.

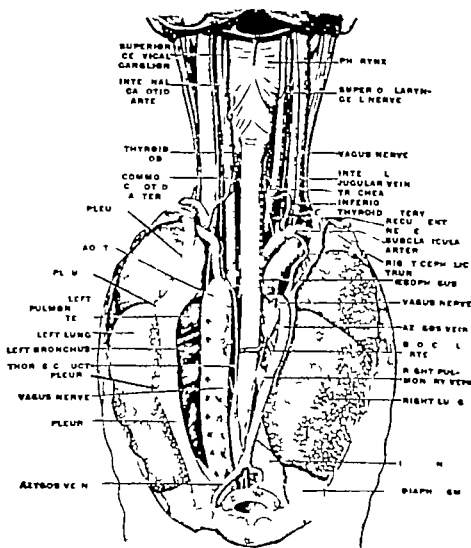


Fig 1: Showing the position and relation of the oesophagus in the cervical region and in the posterior mediastinum. Seen from behind. (From Polier and Charpy)

phageal spasm followed by stasis oesophagitis, contracture, or inflammatory stenosis, and finally cancer. Jackson has pointed out the fact that cancer of the oesophagus often occurs in patients who have had oesophageal spasm for years. Guisez reported 70 such cases.

Mosher has demonstrated the presence of thin webs and pouches in the oesophagus. These may have an etiological bearing as may also the cicatricial contractures which result from the swallowing of caustic solutions or the healing of peptic or traumatic ulcers.

Syphilis does not play an important rôle in the etiology of the disease. It was present in only 7 per cent of our cases. Lamy found syphilis present in 10 per cent of his cases and Jackson reported 14 positive Wassermann re-

actions in his 671 cases (2 per cent). carcinoma of the oesophagus reported in which luetic or tuberculous co-existed. One case reported by Gregg showed cancer syphilis of the oesophagus. Syphilis the general run of the population. same proportion as it was in cancer cases.

INCIDENT

Cancer of the oesophagus is more than 25 per cent of the cases admitted to Memorial Hospital during the year 1910. City during the year 1910. deaths caused by cancer due to cancer of the oesophagus.



Fig. 2.

Fig. 2. Postmortem specimen showing large bulky squamous carcinoma of the esophagus invading the trachea. Bronchopneumonia was the cause of death in this case.



Fig. 3.

Fig. 3. A large shallow ulcerating carcinoma of the



Fig. 4.

esophagus at its lower third. Microscopic section of the lesion showed squamous carcinoma, grade 2, radiation resistant.

Fig. 4. An esophageal cancer of the middle third. Microscopic section showed squamous carcinoma, grade 3.

of 3.38 per cent. Abel reports that cancer of the esophagus makes up 5 per cent of all cancer cases. Ernst 6 to 10 per cent and Litten 8.20 per cent. It is amazing that this very fatal disease should have such a high incidence. The figures, I believe, will appear high even to one actively engaged in cancer work.

SEX

It is well known that this disease is much more common in the male sex. Guiseux with 1,430 cases reported 6 males to 1 female. Jackson with 671 cases, reported 87 per cent males, and in our series of 267 cases there were 225 males (84.3 per cent) and 52 females (15.7 per cent) (Figs. 9 and 10).

AGE

The youngest patient with proved carcinoma of the esophagus treated at the Memo-

rial Hospital was 35 years old and the oldest was a man of 80. The average age of the females was 53.8 years while the average for the males was 57.4 years. Cummins first called attention to the fact that the female sex developed carcinoma of the esophagus at an earlier period of life than did the male. Our figures agree fully with his findings.

SYMPTOMATOLOGY

The onset of carcinoma of the esophagus is most insidious, and although we have the ready means (esophagoscopy) for making a positive diagnosis, it is still a fact that one seldom sees a patient in the early stages of this disease. The function of the esophagus is to transport food from the pharynx to the stomach and this function is seriously interfered with only late in the course of the disease. Then too the patient will masticate

his food more thoroughly after he notices that large particles of food have a tendency to stop or "stick" part way down. Such periods of temporary dysphagia tell a story to the physician but unfortunately the patient pays little heed to such a matter and will mention it only when a careful history is obtained.

When definite persistent dysphagia occurs and the patient seeks relief for it his disease is usually quite advanced. It is most unfortunate that dysphagia should so often be the first symptom of oesophageal new growth. In our series 64 per cent of the patients gave as their first symptom difficulty in swallowing solid foods. If the mortality from this disease is to be reduced, earlier diagnoses must be made and earlier symptoms must be sought for and detected. When dysphagia, dehydration and emaciation exist the disease is hopelessly advanced. Dysphagia is not an invariable finding in oesophageal carcinoma, it may be absent in patients dying of the disease (Cabot Emanuel). In cases of so called "cardiospasm" and other nervous disorders dysphagia may be present for 20 years or more unrelated to malignant disease in the oesophagus. Dysphagia is thus an unreliable symptom and of little aid in making an early diagnosis.

The following vague early but less frequent symptoms noted in this series seem worth mentioning in the interests of early diagnosis. A feeling of substernal pressure was complained of in 6 cases, anorexia, 4 cases, feeling of obstruction 4 cases, hic coughs, 2 cases, hoarseness, 2 cases, difficulty in breathing, heartburn and increased mucus in the throat each 1 case. Foul breath is a common symptom.

The oesophagus is not supplied with sensory nerve fibers and is in itself insensible to pain so that when backache, substernal discomfort or pain do exist it follows that the disease has extended beyond the oesophageal walls into the posterior mediastinum. Hoarseness when present is usually due to paralysis of the left side of the larynx caused by involvement of the left recurrent nerve. Regurgitation, vomiting, loss of weight, weakness and pain are all symptoms of a late stage of the disease. Janeway, Jackson, Torek, Guisez,



Fig. 5. Gross specimen showing a large primary carcinoma of the oesophagus perforating into the right bronchus causing death by asphyxia. A large secondary growth 5 centimeters in diameter is seen several centimeters above the primary lesion. Microscopic section showed the lesion to be an epidermoid carcinoma, grade 3.

and many others interested in this work have made pleas for earlier diagnosis, but the early symptomatology is too vague to be of much help in this direction.

DIAGNOSIS

That the diagnosis of this disease may be completely missed has been shown by Cabot who reported 3,000 autopsies among which were 20 cases of carcinoma of the oesophagus. In 4 of these cases the diagnosis had not been made and in 3 it was merely suspected. This was a higher percentage of mistakes than occurred in any other disease. Oesophagoscopy is more popular now than it was in 1912 when Cabot made his report and undoubtedly the percentage of missed diagnoses has been reduced by that procedure.

Kussmaul in 1868 was the first to realize oesophagoscopy by passing a rigid straight



Fig. 6 Photomicrographs showing the three grades of squamous carcinoma found in the esophagus.

steel tube into the person of a professional sword swallower at Freiburg Mikulicz in 1881 showed that esophagoscopy was a feasible procedure but for the next 35 years there was steady opposition to the practice. Many cases of perforation and death were reported and this state of affairs continued up to comparatively recent years when the technique was made quite safe and the procedure became popular.

It must be emphasized that esophagoscopy is absolutely necessary for the making of an early and accurate diagnosis. Complicated apparatus, difficult roentgen ray technique and various opaque mixtures have been developed with the idea of making an early roentgen ray diagnosis possible but these have lost their popularity due to the more satisfactory esophagoscopic results.

The following diagnostic procedures are carried out at the Memorial Hospital. The patient's history is obtained and he is given a general physical examination. He is then referred to the Head and Neck Department where the oral cavity and larynx are carefully examined and blood drawn for a Wassermann test. Following this he is sent for fluoroscopy and barium swallowing and then X ray films of the esophagus and lungs are taken. With the data obtained on hand the pharynx is cocainized an esophagoscopy is done and a

biopsy obtained. Biopsies are now taken in all uncomplicated cases.

Fluoroscopy is essential for a complete examination because by this means we are able to observe the function of the esophagus. The procedure also determines the following points as regards cancer in this organ: size, shape, outline, and position of the lesion, size and shape of the lumen above and below the obstruction, the presence or absence of small marginal defects (Ernst) and fistulae and lung complications. This data is of utmost value in determining what form of treatment should be instituted. The esophagoscopist if possible should be present during the roentgen ray examination of his patient. By the use of a heavy thick opaque mixture and the taking of X ray films of the patient in several different positions it is possible to obtain a film such as that shown in Figure 11 which gives an accurate picture of the lesion—its position, shape, and size.

Of 203 cases in which the patients were examined roentgenologically positive X ray diagnoses of carcinoma were returned in 97 cases, obstruction in 47 cases, constriction or stricture in 21 cases, filling defect in 29 cases, irregularity in 8 cases, evidence of ulceration in 1 case. In no case was the lesion missed. Jackson reported a positive biopsy in each case diagnosed as cancer by his roentgenologist.

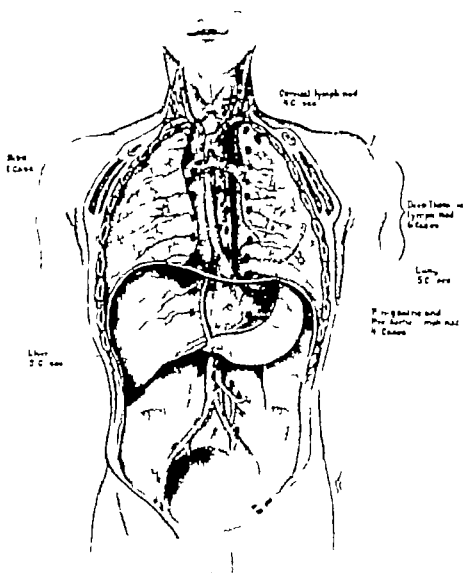


Fig. 7. Diagrammatic sketch illustrating the relative frequency with which the various organs and lymph node areas are involved in secondary deposits from carcinoma of the oesophagus. The diagram is based on 27 postmortem examinations. Of this number 13 cases showed no evidence of metastases.

TREATMENT

Treatment by radical surgery Surgical approach to either end of the oesophagus is readily accomplished and various successful procedures have been developed for radical removal of new growths in these locations. In the cervical region the affected portion of oesophagus is excised and a new tube is fashioned from a transverse skin flap. The operative mortality following this procedure is not high. Turner reports 9 cases operated upon with no mortality and a length of life after operation of 3 months, 4 months, 6 months, 1 year, 14 months and 18 months. At the time the report was made 2 patients were still

alive and well, 1 2 years and the other 9 years after operation. Turner found the length of life was only 4 months in the untreated cases.

The abdominal portion of the oesophagus may be approached by abdominal route and also by a posterior mediastinotomy (Lilienthal). The operative mortality and the end results of a series of cases treated by these procedures does not appear in the literature and one suspects that the results are not satisfactory.

Torek in 1913 reported the first successful case of resection of the thoracic portion of the oesophagus for carcinoma. He obtained a

TABLE III.—METHOD OF TREATMENT

The number of cases treated by the different methods and the average length of life is shown. Patients treated only by gastrostomy were those in which the general condition was too poor to permit palliative radiation.

		Cases	Average length of life after diagnosis (in months)
External irradiation only	Moderate		5.23
	Intense	8	3.39
Intra-oesophageal irradiation only	Radium in capsules		4.84
	Raden seeds		
External plus intra-oesophageal irradiation	Radium in capsules	5	6.7
	Radium in capsules and radon seeds		6
	Raden seeds		
Gastrostomy only		15	3.3
Gastrostomy plus external irradiation		7	6.27
Gastrostomy plus intra-oesophageal irradiation	Radium in capsules	19	3.63
	Raden seeds		6
Gastrostomy plus external and intra-oesophageal irradiation	Radium in capsules	9	3.39
	Radium in capsules and radon seeds		5.5
	Raden seeds		
V. (no use of non-specific treatment)			3

cure. His patient died 13 years later of pneumonia without recurrence of her cancer. In a later communication Torek called attention to the difficulties of the operative treatment and outlined the various causes of failure but concluded that operation offers the only hope of cure. The operative mortality, he believes, can be lowered by careful selection of cases. Saint made a very systematic and impartial review of the surgery so far attempted for car-

cino-ma of the oesophagus. He concluded that the anatomical structure and relationships of the oesophagus, the highly malignant nature of the disease, the frequency of metastases, and the danger of fatal postoperative shock and infection should lead to the use of palliative measures as a routine.

Treatment by irradiation. External irradiation by means of X-ray and radium has in the past been given merely with the hope of retarding the tumor growth and perhaps lessening the severe pain often associated with the late stages of the disease. The dosage has been totally inadequate to cause complete regression. From a review of the anatomy and pathology of carcinoma of the oesophagus, it appears logical to expect more from roentgen radiation of these lesions. With this in mind we are at present using a method of accurately outlining on the skin surface four treatment portals so located that the beams of X-ray will crossfire at the level of the tumor. The beam of radiation is so directed as to pass through the least possible amount of lung tissue. It has been found that 2,000 r may be given through each of four portals without blistering the skin or causing severe constitutional symptoms. This technique is being

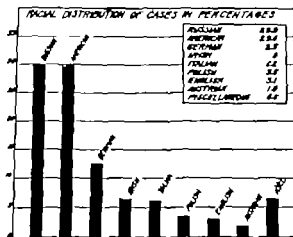


Fig. 8. Chart showing the comparatively large number of Russians in the Memorial Hospital series.

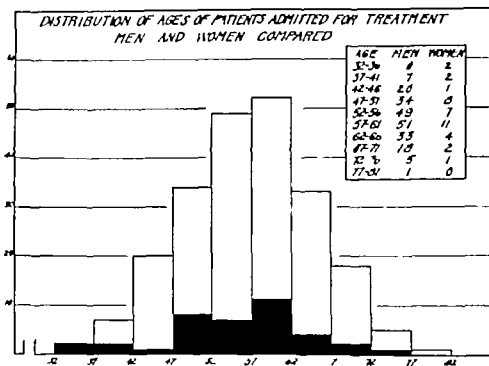


Fig 9. Chart showing the comparative age distribution in carcinoma of the oesophagus. The women are represented by the solid black portions. The female sex tends to acquire carcinoma of the oesophagus at an earlier age than does the male

used in a series of cases and the results will be reported at a later date

Intra-oesophageal irradiation by means of radium in the form of capsules has been used by Guisez in a large number of cases. He reports temporary, but definite decrease in dysphagia in all his cases and his results are surprisingly good. He reports 270 patients treated with intra-oesophageal radium; 30 patients lived more than 18 months, 4 died of intercurrent affections without any evidence of cancer in the oesophagus; 1 was alive 10 years, 1 11 years, 1, 5 years, 4 4 years, 4 3 years, and 12 more than 18 months without evidence of disease. In all these cases biopsies were positive. He uses radium tubes of Dominica arranged in tandem and held in a bougie by means of which the tubes are accurately placed in relation to the tumor. Two or three tubes with a total of 10 to 12 centigrams of radium bromide screened by 1.5 millimeters of platinum are used and inserted every 2 days for 10 to 12 hours. Five or six treatments are usually given. Of the cases which we have treated by intra-oesophageal irradiation none has lived long enough to encourage us to continue with this method.

The insertion of gold filtered radium emanation seeds directly into the tumor has given only indifferent results (Table III).

Intra-oesophageal manipulations. Bougienage and dilatation of the carcinomatous stricture has been given a trial at the Memorial Hospital. The deliberate tearing and stretching of a carcinomatous stricture with the resultant opening of new blood and lymph channels for dissemination of disease together with the danger of rupture of the oesophagus, haemorrhage and fatal sepsis have led us to limit the number of cases treated by this method. During the later stages of the disease it becomes impossible to dilate the lumen and a gastrostomy becomes necessary unless one elects to send the patient home to die slowly of starvation.

None of the cases in our series was intubated or treated by coagulation with the high frequency current. These methods are occasionally advocated in the literature.

Palliative treatment. Gastrostomy if done early in the course of the disease should have practically no operative mortality. If this procedure is carried out in every case regardless of the stage of the disease a certain num-

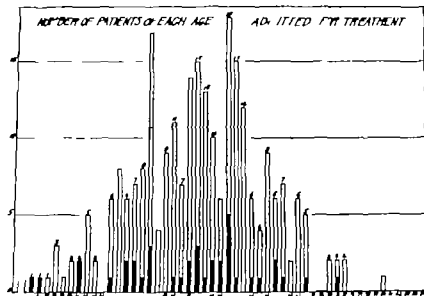


Fig. 6. Chart showing the number of cases of each age. The youngest patient in this series was a woman 35 years of age, and the eldest was a man of 80. More cases, male and female, acquired the disease during their sixtieth year than during any other similar period of time. The females are represented by the solid black.

ber of cases will die after operation but the causes of death will usually be due to perforation into the aorta with fatal hemorrhage, pneumonia from a broncho-oesophageal fistula (Fig. 12) mediastinitis etc. Such must be called postoperative deaths but they are in reality deaths due to the patient's disease. In most cases the operation is done under novocain infiltration and block anaesthesia and is accomplished without shock to the patient who sits up in bed on return to the ward and is fed through his gastrostomy tube immediately. He is out of bed on the third day after operation and soon begins to gain weight. The dysphagia definitely decreases and the patient's morale improves with his strength. Our recent results with gastrostomy are very encouraging and these statistics together with a description of the operative technique have been published (Martin and Waston).

At Memorial Hospital palliation has been aimed at and gastrostomy is usually done unless contra indicated or refused by the patient. This procedure has been combined with external or intra-oesophageal irradiation and in some cases with both. Seventy-one patients having had gastrostomy and external

irradiation lived an average of 6.27 months after treatment. Twelve patients treated by moderate doses of external radiation lived an average of 5.33 months after treatment. Table III shows the number of patients treated by various methods and the results.

PROPHYLAXIS

We do not see cancer of the oesophagus in patients with sound healthy clean teeth. Oral sepsis is usually advanced or if the patient be edentulous, it is possible to obtain a history of preceding dental caries in most cases. It seems to be a frequent disease among the Russian poor who take very little care of their teeth. Prophylaxis should begin with care of the teeth. Alcohol hot fluids, excessive use of tobacco and spiced food should be eliminated. Slow and complete mastication of food would prevent oesophageal trauma. Patients with oesophageal spasm must be treated and the public educated to the possible seriousness of such trifling symptoms as a feeling of substernal pressure and temporary dysphagia.

PROGNOSIS

Carcinoma of the oesophagus is a rapidly fatal disease. The average length of life from



Fig. 11 Carcinoma of the esophagus showing the detail which may be brought on by careful radiographic technique.



Fig. 12 Roentgenogram on admission showing a broncho-oesophageal fistula developing in a carcinoma of the esophagus. This patient had a gastrostomy performed for feeding purposes and improved enough to return home in 2 weeks after operation.

the onset of symptoms in this series was $10\frac{1}{2}$ months and the average length of life after application to the hospital was 4.83 months in the 208 cases followed. The disease advances so swiftly when symptoms are present that a fatal termination occurs often before metastases are demonstrable at autopsy. The disease spreads by three methods direct extension lymphatic permeation and the blood stream. At one time it was thought that the small islands of new growth sometimes seen dotted about the mucous membrane some distance from the primary lesion were carcinoma implants. Since then it has been shown however that these were really upshots to the surface of permeated intramural lymphatic

vessels. Table IV gives the average length of life in the different groups.

Of the thousands of cases of carcinoma treated yearly there has been a salvage of not more than 10 cases. The lethal nature of the disease becomes increasingly important when we realize that from 3 to 4 per cent of all cancer deaths occur in patients with carcinoma of the esophagus. The high mortality and the relative frequency of the disease make worth while the studying in detail of any large series of cases with the hope that some clue to an earlier diagnosis may be obtained or a more rational method of treatment suggested. A

TABLE IV—AVERAGE LENGTH OF LIFE IN EACH GROUP

Epidermoid carcinoma	Grade	Grade	Grade 3	Adenocarcinoma	Transitional cell
Cases with complete data		8	20	13	5
Average length of life from onset of symptoms (in months)	6.34	8.7	1	18.68	14.6
Average length of life after admission to hospital (in months)	1.60	4.15	4.5	7.73	8.7
Average length of life after operation (in months)	2.55	3.74	3.83	5	7

mortality of practically 100 per cent seems a hopeless situation and small recompense for the time and effort which has gone into the investigation of this disease. It seems wise to attempt a cure only in the very few favorable cases and to treat the remainder in a routine palliative fashion—possibly best by external irradiation combined with gastrostomy.

SUMMARY

1 Intimate knowledge of the anatomy and histology of the esophagus is essential to the understanding of the treatment problems of cancer in this organ.

2 The exact etiology of esophageal carcinoma is still obscure but definite predisposing and exciting factors are known and should be an aid in prophylaxis.

3 Cancer of the esophagus makes up between 3 and 10 per cent of all the carcinoma deaths.

4 The disease is most frequent in the lower third of the esophagus.

5 Of the 267 cases with positive biopsies 15 were grade 1 148 grade 2 39 grade 3 19 adenocarcinoma, 6 transitional cell carcinoma and in 40 cases the tissue was unsatisfactory for grading.

6 Adenocarcinoma of the esophagus are more slowly growing and give symptoms earlier than do the squamous cell lesions.

7 Of the cases coming to autopsy 48 per cent showed no evidence of metastases.

8 Bronchopneumonia was a cause of death in 48 per cent of the cases.

9 Radical surgery of the esophagus is indicated in a few early cases.

10 The routine treatment should be palliative.

11 Gastrostomy followed by external irradiation offers the most satisfactory palliation.

12 Prophylaxis should be stressed.

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DIVERTICULUM OF THE URINARY BLADDER

AN ANALYSIS OF ONE HUNDRED CASES¹

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THE status of bladder diverticulum has passed from a rare clinical entity to a common urologic diagnostic finding. It is a far cry since there appeared in all but 6 cases in the American literature and when other contemporary reports showed but 6 collected cases from the world's literature in which the sac had been excised. Prior to the present century the occurrence of diverticulum was usually found upon postmortem examination. The ready facility now of its clinical recognition is due to the progress achieved in cystoscopic and roentgen ray procedures in urologic diagnosis.

Diverticulum of the urinary bladder has led to some interesting anatomicophysiological problems, chief of which have been etiology and anatomy. Various theories have been promulgated and according to these theories diverticula may be divided in four principal groups: (1) diverticula which are caused as a result of congenital and acquired factors; (2) diverticula congenital in origin; (3) diverticula of the acquired type; and (4) diverticula that may be either purely congenital or purely acquired.

Some observers maintain that diverticula are congenital and have based such an opinion on the fact that they occur in infants and young children. Others have contended that all diverticula are acquired since they are rarely found when urinary obstruction is absent. Most of the present day observers take a more logical intermediate viewpoint namely that diverticula may be the result of both congenital and acquired factors. They may exist from birth chiefly those in the fundus while the remainder are secondary to back pressure such affected bladders probably giving way at their points of congenital weakness. An analysis of the present series of cases leads the writer to the same conclusion since it was possible nearly always to demonstrate

some type of bladder neck or urethral obstruction.

Anatomically the walls of the diverticula are essentially composed of fibrotic and connective tissue fibers permeated with inflammatory elements. Some observers have reported the finding of occasional bundles of muscle fibers which when present are said to be widely scattered or interwoven with the fibrous tissue. There is no evidence of any layer formation similar to that found in the bladder wall proper. Usually all diverticula have a smooth glistening lining membrane unlike the bladder mucosa in appearance and showing histologically a flattened type of epithelium. This has not however been substantiated by some observers. Examination of the pathological material from the diverticulectomies in the present series of cases revealed that the diverticula were composed of fibrous tissue with chronic inflammation. A lining epithelial membrane was present in all and appeared histologically to be of a more flattened squamous type than that found in the bladder proper.

Clinically, diverticula of the bladder have presented many interesting facts. There is no distinctive symptomatic syndrome. This lack of symptoms makes their recognition by diagnostic procedures with the cystoscope and X-ray one of importance. At times the presence of diverticula may not be discovered by these urological diagnostic procedures but may later be found at open operation. Significant factors, as situation in relation to position and drainage, size of the orifice and sac, number, exact nature of the etiological obstructing factor, type of urinary infection must be carefully ascertained. Recognition of such complicating associated factors as calculus, carcinoma, leucoplakia and tuberculosis are of paramount importance if the condition is to be adequately remedied. Treatment in most cases has been the relieving of the ob-

¹Read before The California Medical Association, May 9, 1931.



Fig. 1A. Cystogram showing typical vesical diverticula, one large and several smaller ones, associated with a vesical obstruction due to a benign hypertrophy of the prostate. The irregular outline which is to be noted in



the remainder of the bladder is due to cellule formation.
Fig. 1B. Drawing demonstrating anatomically the orifice of a true diverticulum into the bladder shown in the accompanying cystogram.

structing factor. If the diverticulum is of the retention type urinary stasis occurs which usually leads to severe urinary infection with organisms of the urea splitting type, as the streptococcus, staphylococcus or *Bacillus proteus*. Such an infection may result in a very irritating ammoniacal urine and therefore such diverticula must also be treated either by resection of the entire sac or a plastic procedure to their orifices so as to insure proper drainage. The latter procedures are also usually applied to large diverticula.

There have been observed 100 cases of bladder diverticulosis in the Los Angeles General Hospital within the last 5 years and for that reason the following analyses and conclusions are detailed.

ANALYTICAL SUMMARY OF ONE HUNDRED CASES OF DIVERTICULA OF THE URINARY BLADDER

During the last 5 years there have been 5984 admissions to the urological service. Among these have been observed 100 cases of

diverticulosis. These cases have been divided into two groups: true diverticula and false or incipient diverticulosis. The basis for this division is upon the criteria that false or incipient diverticula are for the most part cellules or shallow wide mouthed depressions due to the protrusion outward of the epithelial lining between hypertrophied muscle bundles and are nearly always multiple and found throughout the bladder (Fig. 2), the true diverticula are more commonly single and larger in size, exhibiting a definite orifice having an anatomical sac like structure, and are usually situated in the region of the ureters (Fig. 1).

There were 72 of the true type and 28 of the false cases. This makes an incidence of 1.2 per cent or one in every 83 general urological admissions. Of the 72 true cases, 43 were found among 467 cases of benign hypertrophy of the prostate or an incidence of 9.1 per cent (1 in 10.8), 14 were among 83 bladder neck contractures and median bars—11.8 per cent (1 in 5.8), 3 were among 254 carcinomata of



A.

Fig. 2A Cystogram showing a shallow irregular and undented bladder outline due to diffuse cellulose formation or early (false) diverticulosis.



B.

Fig. 2B Drawing of anatomical formation of a bladder with early (false) diverticulosis or cellulose formation and resulting in a cystographic outline shown in Figure 2A.

the prostate—1.1 per cent (1 in 84) and 3 were among 21 urethral strictures necessitating operation (external urethrotomy)—14.2 per cent (1 in 7) (Table I). It is interesting to note

from these figures that the relative incidence is more common among bladder neck contractions, median bar and urethral strictures than in the presence of benign hypertrophy of the prostate.

An analysis of the symptoms shows that bladder diverticulum is not a distinct clinical syndrome (Table II). The incidence of various urinary disturbances presents a clinical picture similar to that of an obstructive uropathy in the lower urinary tract (bladder neck and urethra) with a complicating infection. Frequency in 53 cases, difficulty in 44 cases, nocturia in 40 cases, dysuria in 39 cases, dribbling in 27 cases and burning in 23 cases were the symptoms most frequently encountered. Twenty-one cases entered the hospital with complete retention. The outstanding characteristic of the symptomatology was the

TABLE I—INCIDENCE—1927-1931

	Number	True diverticula	False diverticula	True cases	
				Percentage	Ratio
Total urologic admissions	5084	7	23		1:81
Prostatitis					
Benign hypertrophy	467	43		9	11:8
Contracture					
Median bar	83	1	4	14.8	7:8
Carcinoma	134	3			4:1
Urethral stricture					
Contracting sphincter	21	3		14	7



A



B



C

Figs. 3A and B Diagnostic demonstration of a retention diverticulum by means of the contrast cystographic method utilizing 12½ per cent sodium iodide and air

Fig. 3C Illustrating a second cystoenterographic method of diagnosis in which an ureteral catheter is coiled up in the diverticulum.



Fig. 4.



Fig. 5



Fig. 6

Fig. 4. Cystogram showing several definite true diverticula in a woman in whom the only obstructing factor that could be demonstrated was an hypertrophied bladder trigone.

and a diffuse early diverticulosis in a man with a spinal cord injury

Fig. 6. A contrast air cystogram in a woman. The retained sodium iodide is held in a pericyclic abscess connecting directly with the bladder and not in a diverticulum

Fig. 5 Cystogram illustrating one large diverticulum

long duration, some patients having had urinary disturbances, in a mild form, well on to 15 years.

A distribution of 97 cases in men and 3 in women emphasizes the fact that diverticulum of the bladder is a disease of the male urinary bladder. Most cases were found in later life 91 per cent occurring after the age of 50 years, the largest number in any one period was 42 and occurred in the seventh decade of life. No infants nor children were encountered (Table III). This distribution can be assumed

as supporting the "acquired theory," showing that it is necessary first that an obstructive process develop

True diverticula of the bladder tend toward singularity for instance, 38 cases had 1 diverticulum 21 cases had 2 and 12 cases had 3 or 4. This distribution of the diverticula was essentially in the ureteral region as evidenced by the fact that in 24 cases the opening was in the right ureteral region in 13 in the left ureteral region in 22 the openings were bilateral and in 7 in the posterior and fundal



Fig. 7A, left. Cystogram illustrating an opening in the fundus of the bladder caused by a perforating intestinal carcinoma. Such a picture may be confused with diverticulum.

Fig. 7B. Roentgenographic visualization of the intestinal tract of the same case. The obliterated portum *I* is the site of the growth while *F* is the course of the fistula connecting with the bladder.

areas (Table IV). A total of 65 of the 72 true cases (90 per cent) were found in the region of the ureters and this fact can be taken as further confirmatory evidence that the weakest points in the bladder musculature are in the vicinity of the ureteral orifices or that there may remain from a faulty embryological development small patent ureteral buds which in later life develop into diverticula, a fact that must be considered in some cases in women in whom examination fails to disclose any obstructing factor. This may be explained by the embryological development of the ureter

as it buds off the cloaca or by the fact that there can occur an absence of longitudinal muscle at these points. It may therefore be considered that a bladder wall must possess congenitally weak areas as the site of election for diverticulum formation but that a diverticulum may never occur in the male unless there is an obstructive factor at either the

TABLE II.—SYMPTOMATOLOGY

	Cases
Frequency	53
Difficulty	44
Nocturia	40
Dysuria	29
Dribbling	27
Burning	23
Retention	21
Hematuria	12
Urgency	10
Hesitancy	6
Backache	5
Epididymitis	2
Tenesmus	1
Chills and fever	
Loss of weight	
Weakness	
Suprapubic pain	1
Pain in right flank	1
Suprapubic sinus	1

TABLE III—AGE

Years	Cases
0-1	0
1-20	
21-30	3
31-40	3
41-50	4
51-60	4
61-70	42
71-80	25
8-90	10
Total	100

9 cases (9 per cent) within postnatal age

TABLE IV—LOCATION*

	Cases
Right ureteral region	24
Left ureteral region	3
Bilateral	21
Right ureteral and fundus	4
Left ureteral and fundus	1
Bilateral and fundus	1
Fundus and posterior	2
Generalized or incipient diverticulosis	25
Total	100

*65 of 72 true cases (90 per cent) in region of ureters.



Fig. 8. Cystograms showing various bladder deformities associated with diverticula of the male urinary bladder
 A Hour-glass deformity B Illustrates an elongation of

the fundus with multiple diverticula C Fixed fundus resulting in a broad outline

bladder neck or in the urethra. Such bladders as have no congenitally weak areas may in the presence of a urinary obstruction give rise to only a diffuse formation of deep trabeculations or cellules (grouped in this series as incipient diverticulosis).

In most cases there was residual urine 7 patients having 50 cubic centimeters or less 19 between 50 and 100 cubic centimeters 16 cases 100 to 200 cubic centimeters and 23 over 200 cubic centimeters. In 21 patients there was complete retention.

TABLE VI — ASSOCIATED CONDITIONS

	Cases
Calculi	
Bladder	12
(Including 5 cases with calculi in diverticulum)	
Upper urinary tract	3
Prostatic	1
Total calculi	16
Luxes	7
Bladder tumors (carcinoma)	2
Papillary carcinoma of intestine invading bladder	1
Epithelioma of kidney pelvis	1
Adenocarcinoma of rectum	1
Epithelioma of ear	1
Diabetes	1
Total	30

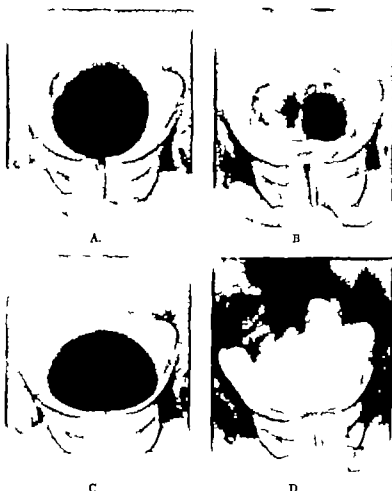
TABLE V — ETIOLOGICAL CONDITIONS

Condition	True cases	False cases	Total Cases
Prostatitis			
Hypertrophy contracture	43	11	54
Median bar	14	4	18
Carcinoma	3		3
Urethral stricture	3	0	3
Carcinoma of bladder			1
Cord injury	1	0	1
Spontaneous purpura			
Urethral caruncle (female)		0	1
Hypertrophied trigone (female)		0	1
Unknown		0	1
Not stated (female)	3	0	3
Total	7	11	18

*Total, 90 per cent of cases

TABLE VII — TREATMENT

	Cases
To etiologic condition	
Prostatectomy (One stage suprapubic)	2
(Two stage suprapubic)	38
(Perineal)	4
Total	44
Punch (Open)	11
(Closed)	4
Total	15
Cystotomy	15
Prostatic resection	1
Grand Total	75
To diverticula	
Diverticulectomy	8
Squarer operation	3
Punching orifice	3
Percy cautery	3
Total	17
No treatment	18
Refused treatment	3



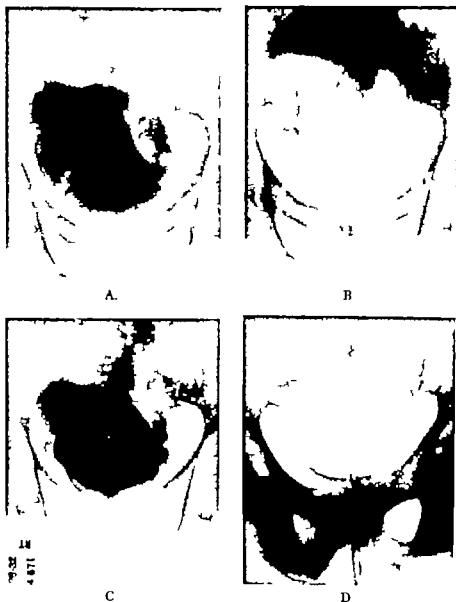
Figs. 9A and B Contrast cystograms showing two retention diverticula on the posterior wall of the bladder.

Figs. 9C and D Contrast cystograms several months after diverticulectomy demonstrating a good anatomical result.

An analysis of the etiological conditions showed that prostatism and urethral stricture especially the former were the dominant productive factors in 90 male patients. There were 64 cases of benign hypertrophy with 43 cases of true diverticula 18 cases of bladder neck contracture and median bar formation with 14 cases of true diverticula 5 cases of prostatic carcinoma with 3 true cases 3 cases of urethral stricture with true diverticula the remainder were individual cases of urethral caruncle (female) hypertrophied trigone (female) bladder carcinoma, cord injury, spastic paraplegia, and 3 cases (1 female) not stated (Table V).

In 30 cases there were associated conditions. Sixteen exhibited urinary calculi distributed as follows 12 with vesical calculi 5 of which were within the diverticulum 3 with renal calculi and 1 with prostatic calculi. Seven patients had lues 2 had carcinoma of the bladder and 1 each had an epithelioma of the kidney pelvis adenocarcinoma of the rectum, epithelioma of the ear a papillary carcinoma of the intestine invading the bladder and diabetes (Table VI). In none of the cases of diverticula was there found an associated neoplasm, leucoplakia, or tuberculosis.

Treatment was directed chiefly toward the etiological condition and secondarily to the



Figs. 10A and B. Contrast cystograms demonstrating a large retention diverticulum in the right wall of the bladder. There are several smaller diverticula on the left wall but these drain well.

Figs. 10C and D. Contrast cystograms 14 months after treatment with the Percy cautery to the diverticulum and its orifice. Although there has been a slight change in actual size, satisfactory drainage has been achieved.

diverticulum if it was of the retention or large type. Upon this basis the etiological condition was corrected or treated palliatively in 75 cases and the diverticulum was treated directly in 17 cases. In 44 cases prostatectomy was done (2 in one stage, 38 in two stages and 4 by the perineal route), in 15 cases bladder neck punch operations were done (11 open and 4 closed), in 15 cystotomy was done and in 1 a prostatic resection with the high frequency loop. In the 17 cases in which the diverticulum was treated directly

the following operations were done: divertic ulectomy, 8 cases; the Squier operation, 3 cases; orifices punched out, 3 cases; Percy cautery, 3 cases (Table VII).

A study of the follow up letters has shown that our method of treatment was adequate in the majority of operative cases. Most cases showed improvement as evidenced by a marked diminution in symptoms and urinary infection, disappearance of residual urine and distinct gain in general health. Follow up cysto-urographic studies of such treated cases

as could be reached who had had a prostatectomy or had had in addition some plastic work on the diverticulum orifice revealed for the most part very little change in the size of the diverticulum proper. However the important factor—drainage—had been achieved. An excellent anatomical result was obtained in the several patients who had had a diverticulectomy. From our data it may be inferred that a minimum amount of attention may be paid to the diverticulum proper but that it is most important to remove all etiological obstructing factors and to institute thorough drainage. If such has been achieved and there are no diverticula of the retention type present the patient will be greatly benefited.

Unless the indications be definite such as retention, poor drainage, marked infection, small orifices, diverticula for the most part can be ignored following the remedying of the bladder neck obstruction. Attempts to treat surgically some types of diverticula, as for instance those situated in the subtrigonal and ureteral regions, may lead to much additional technical difficulty, often producing surgical shock and even death.

CONCLUSIONS

1. Diverticulum of the urinary bladder is a disease which affects the male chiefly and occurs for the most part in later life during the

prostatic age. It is nearly always associated with an obstructive condition as prostatism or urethral stricture.

2. The incidence of diverticulum is as follows in the urologic cases in general: 1.2 per cent in benign hypertrophies, 9.1 per cent in contractures and median bar obstruction, 16.8 per cent in urethral strictures necessitating operation, 14.3 per cent and in carcinoma of the prostate 1.1 per cent. No definite clinical symptomatology is noted except possibly if a lower urinary tract obstruction with infection is present there is an accentuation of the characteristic symptoms of the associated condition.

3. Diverticulum of the urinary bladder is the result of both congenital and acquired anatomical factors.

4. Anatomically it was found in the present series that the walls of the diverticulum showed fibrous tissue with permeation of chronic inflammatory elements. The diverticula were lined with smooth, glistening membrane histologically the flattened type of epithelium.

5. Diverticulum of the urinary bladder is treated most satisfactorily by the correction of the obstructing factors, only such diverticula being individually treated as may be of the retention type or of a large size. This method of procedure will give gratifying relief from symptoms that have been intense and of long duration.

HYPERTROPHIC INTESTINAL TUBERCULOSIS¹

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THE present paper is based upon a review of twenty nine cases of hypertrophic tuberculosis of the intestine treated in the Surgical units of the Manchester Royal Infirmary during the past ten years. The number of cases recorded is small the disease being a comparatively rare one (during the same period and in the same institution the number of patients admitted suffering from intestinal carcinoma was 1123). The results of surgical intervention however particularly when of a conservative nature have been so generally successful in this group of cases that it is suggested that a statistical consideration of the etiology and treatment of the disease based upon them might be of value.

It is perhaps advisable to indicate at the outset that consideration is limited entirely to those cases corresponding to Type 4 of the so called 'French' classification of intestinal tuberculosis. This which is purely a pathological one enumerates the following varieties: (1) the ulcerating type or tuberculous enteritis; (2) the stenosing type; (3) the enteropneumonic type; and (4) the hypertrophic type.

Types 1 and 2 being invariably secondary to phthisis in adults and forming the bulk of intestinal cases in children constitute the overwhelming majority of all cases of intestinal tuberculosis. The remaining types are comparatively rare but as one of these the last is the only variety amenable to surgical treatment—with the exception of those secondary cases in which perforation or acute obstruction demand urgent relief—it is only this type which is seen with any degree of frequency by the surgeon.² This is illustrated by the fact that of the 35 cases of all types of intestinal tuberculosis treated in the surgical wards of the Royal Infirmary during the period under review 29 were of the true hypertrophic variety.

A comparative analysis of these cases follows.

ETIOLOGY

Situation. The situation of the focus of disease is indicated in Table I.

TABLE I—DISTRIBUTION OF THE LESIONS

	Cases
Ileocaecal region	12
Sigmoid colon	3
Hepatic flexure	1
Ascending colon	1
Appendix	1
Jejunum	1
Total	20

These figures correspond fairly closely to the majority of published surgical data. Of Mummery's list of 100 collected cases of hyperplastic tuberculosis affecting the colon 87 involved the caecal region 6 were confined to the sigmoid while the whole or a large part of the colon was invaded in the remaining 7. Anderson and Munro reporting 9 similar cases state that 6 were of the caecal type 2 were situated in the transverse colon while 1 was of the diffuse type involving the ascending and transverse limbs. No cases involving the transverse colon occurred in the Infirmary series. It is a rare lesion only 2 of 43 cases of hyperplastic intestinal tuberculosis reported by Caird being affected in this region. Similarly I have been unable to find in our series an example of the peculiar 'gas-pipe' colon where the whole colon is the seat of a generalized tuberculous thickening but this is scarcely surprising as the type is extremely rare the only published cases being single ones reported by Briddon, Lartigau, Elliott and Mummery.

Age incidence. The average age of the patients was 30 years the youngest being 9 the oldest 69 years.

These figures correspond closely to similar published statistics. The average age in Mummery's 80 cases was 32 years the oldest patient being 78 years and the youngest 7. Erdman's 6 cases gave an average age of 30.

¹ The extensive operative procedures advocated by Archfield, of Montreal, for uncomplicated secondary tuberculous enteritis have never been widely adopted, in spite of the good results claimed by this author.



Fig. 1. Hypertrophic ileocecal tuberculosis. Case No. S 266 29. } G. male aged 63 years. Symptoms of chronic intestinal obstruction for 6 months, with a large fixed tumor in the right iliac fossa. Operation, November 20, 1929, ileotransverse colostomy (tumor irremovable). Examined November 2, 1931 and found fit and well. He has gained one stone in weight, has no intestinal symptoms. Tumor is palpable. (Postoperative barium enema X-ray refused. X-ray by Drs. Paterson, Twining, and Gray.)

years. Very similar figures are reported by Nikolyski, Mueller, Shiota and Kuettner. It is of interest to note that this average age of 30 years is also the average age of several large series of phthisical patients.

Sex incidence. Twenty-one of the cases were females and 8 males.

This sex incidence is somewhat different from that usually accepted, namely, that the sexes are affected with equal frequency. This ratio is illustrated by the list of published figures quoted by Mummery (Table II).

TABLE II.—SEX INCIDENCE

	Cases	Males	Females
Mummery	80	47	33
Conrath	77	36	41
Bernay	71	40	3

Mueller actually reverses the order by stating that males are affected more than females in the proportion of 3 to 2. The discrepancy, one supposes, is due more to the (comparatively) small number of cases reviewed than to any etiological factor.

Incidence of tuberculosis elsewhere. Table III is self explanatory.

TABLE III.—INCIDENCE OF CONCURRENT TUBERCULOUS LESIONS

	Cases
Phthisis	3
Jejunal ulcer	1
Hyperplastic tuberculosis of rectum	1
Tuberculous arthritis of elbow joint	—
Tuberculous ischiofemoral abscess and tuberculous structure of ileum	6
Percentage	20

It will be seen that only 2 of the patients suffered from phthisis—(one may add in parenthesis that now both these patients are free from active disease)—while 3 others had coincident tuberculosis of some part of the gastrointestinal tract. These findings are in accord with the generally accepted view that the disease is not usually associated with tuberculosis elsewhere except in a small though definite proportion of cases. It is interesting to note that the percentage of cases free from other tuberculous disease in Mummery's series, namely 24 per cent, is very close to the figure of 20 per cent in the Infirmary group. (Four of Erdman's 6 cases had quiescent phthisis, but it would appear unjustifiable to accept percentages based on such a small figure.)

The question of primary or secondary infection. These results throw little light on the interminable discussion as to whether hypertrophic intestinal tuberculosis is truly a primary or a secondary disease. Cumston believes that it is almost always primary. Hemmeter that it is usually secondary to phthisis and all variations of opinion between these two extremes have been registered by various authorities. A variety of causes would appear to account for these differences. In the first place, it is probable that too much importance has been attached to the 2 classical cases of Lartigau and Beck in which each observer failed to find any evidence of tuberculosis elsewhere in spite of a most exhaustive and minute postmortem examination. It is surely an exaggeration to make these isolated findings the basis of a contention that all the cases are primary in origin. Second assumptions based on the review of a small number of cases, with consequent misuse of the percentage system, must inevitably lead to many fallacies. In the third place, most of the

TABLE IV — DURATION OF SYMPTOMS

Average duration	20 months
Shortest duration	3 days
Longest duration	10 years

TABLE V — INCIDENCE OF INDIVIDUAL SYMPTOMS

	Cases
Alternating constipation and diarrhea	6
Constipation only	15
Diarrhea only	4
Bowels regular	3
Blood in stools	2
Slime in stools	3
Blood and slime in stools	3
Palpable mass present in 18 cases (65 per cent)	

TABLE VI — SYMPTOM SYNDROMES

	Cases
Syndrome of chronic intestinal obstruction	15
Syndrome of chronic intestinal obstruction with alternating constipation and diarrhea	6
Syndrome of acute intestinal obstruction	1
Syndrome of recurrent appendicitis	4
Syndrome of acute appendicitis	3
	29

larger series include in the figure all the widely varying types of intestinal tuberculosis in spite of the fact that (at least in adults) the very common ulcerative type is almost invariably secondary. In this connection some figures quoted by Lawrason Brown and Sampson are of interest. On postmortem examination Heller found primary intestinal tuberculosis in 16 of 107 cases (in children in whom the incidence of the primary type is admittedly most common). Bonome in 126 cases out of 769 cases of tuberculosis. Biedert in 16 out of 3104 cases of tuberculosis, Bovaard in 150 out of 1481 tuberculous cases, while Gant in a collected series of 22 725 autopsies, found primary intestinal tuberculosis present in 7.22 per cent. Hartmann goes so far as to state that 85 per cent of all cases of tuberculosis of the intestine in adults is of the hyperplastic type.

Careful assessment of most of the published figures of postmortem clinical and X-ray findings suggest that roughly 70 per cent of all cases of hypertrophic intestinal tuberculosis are truly primary in origin. It will be noticed that both in Mummery's and the Royal Infirmary series this figure is closely approximated.



Fig. 2. Hypertrophic tuberculosis of hepatic flexure. Case No. S 833/24. J. W. male aged 45 years. Three months history of subacute intestinal obstruction. Loss of weight very marked. Large fixed tumor in right hypochondrium. Operation, September 22, 1924, ascending transverse colocolostomy (tumor irremovable). Examined November 12, 1931, and found to be in excellent health. Weight steady. No intestinal symptoms. (Postoperative barium-enzyme X-ray refused) (X-ray by Drs. Paterson, Twining, and Gray).

SYMPTOMS

The duration of symptoms, the incidence of individual symptoms and the types of symptom complex are summarized in the Tables IV, V, VI.

It will be noticed that of the various symptom complexes exhibited the commonest is that of a subacute intestinal obstruction with intermittent attacks of intestinal colic, a definite tendency to constipation with very occasional attacks of diarrhoea, the whole extending over a fairly lengthy period of a year or more. Alternating constipation and diarrhoea, the presence of blood or slime in the stools or diarrhoea alone are only very occasional symptoms but a striking feature is the presence in 65 per cent of the cases of a palpable abdominal tumor noticed in more than half that number, by the patient himself. In one case acute intestinal obstruction, a complication of comparative rarity, supervened. The

TABLE X.—WARWICK STATISTICS

Observer	Cases	Number affected by tuberculosis	Percentage
Montreal General Hospital	1,359	20	1.6
Allen	80	2	2.5
Lits	257	8	3
Robson	300	5	1.7
Letulle	300	2	.7
Univ. of Pennsylvania	310	6	2
Deaver	7,610	16	.2
Scott	79	1	.5
Mayo	12,003	71	.5
Warwick	210	2	1
Total	22,508	133	1.3%

communication to Masson. He mentions 7 cases of ileocecal tuberculosis which were so improved by a first stage lateral anastomosis that further treatment by resection was unnecessary.

The possibility of carcinoma supervening is probably much exaggerated, though there is no doubt that it does exist as two cases recorded by Herzog testify but it is so rare that it may be completely discounted as an argument for resection.

PRIMARY APPENDICULAR TUBERCULOSIS

One case confined to the vermiform appendix occurred in our series. The symptoms were those of typical recurrent appendicitis culminating in an acute attack, for which the appendix was removed and only shown on microscopic examination to be tuberculous. The other organs were apparently normal. The patient unfortunately is untraceable.

This subject has been exhaustively reviewed by Warwick, who quotes Scott's collected figures concerning the frequency with which tubercle is encountered in the routine examination of all appendices removed for other conditions, principally acute appendicitis. The list shown in Table X is modified from her paper.

In a series of collected English cases, Lock

wood found the percentage affected to be 2. Analysis of the Mayo Clinic figures show a considerable decline in the incidence during the last 2 decades, a change ascribed by W. J. Mayo to the almost universal adoption in America of the clean milk supply.

HYPERTROPHIC TUBERCULOSIS OF THE SMALL INTESTINE

An example of hypertrophic tuberculosis involving the jejunum 18 inches from the duodenojejunal flexure, occurred in our series. This is an extremely rare condition, so uncommon that I have been able to find no more than 8 cases recorded in the literature. (Masson and McIndoe, Cunningham and Sniersen, Garvin, Counsellor, Lartigan.) The patient, a man aged 51, gave a 6 weeks' history of sub-acute intestinal obstruction with severe colic like pain and vomiting. Examination revealed a mass in the right iliac fossa, diagnosed at operation as a carcinoma of the upper jejunum. The tumor was excised with some inches of bowel on either side and end-to-end jejunostomy was performed. Subsequent microscopic examination gave the true diagnosis. Two and a half years later the patient states that he is in perfect health.

CONCLUSION

The subject of this inquiry was suggested by an observation of W. J. Mayo's (quoted) commenting on the freedom from symptoms enjoyed by several patients, following a first stage short-circuiting operation for ileocecal tuberculosis. Investigation into the after history of twelve similar cases similarly treated has shown an identical result, with complete freedom from symptoms, disappearance of the tumor when present, and rapid improvement in general health, in all the cases, at intervals varying from 1 to 4 years after operation.

It is suggested therefore in view of these and similar published statistics that the view generally held that complete eradication is a *sine qua non* in the effective treatment of this disease is fallacious, and that focal excision in view of the mortality implicated, is an unnecessary procedure, except in picked, suitable cases.

I am indebted to the honorary surgeons and assistant surgeons of the Manchester Royal Infirmary for permission to investigate their cases, and particularly to Professor E. D. Telford, for his kind help and advice.

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THE EXCRETION OF OVARY STIMULATING HORMONE IN THE URINE DURING PREGNANCY

ITS RELATION TO URINARY OUTPUT

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THIS report concerns the amount of ovary stimulating hormone which is excreted in the urine during pregnancy and the effect of alteration in the output of urine upon the rate of excretion of the hormone. No report was found in the literature which recorded the measurement of the hormone in the urine, by the use of the rabbit test of Friedman¹ and none occurred which dealt with the relation between the output of urine and the excretion of hormone as measured by any method. For these reasons the present study was undertaken.

EXPERIMENT

The amount of urine passed in 24 hours by a series of 24 pregnant women was measured and the hormone content determined. A correlation between the sizes of the specimens and the amounts of hormone which they contained forms the basis for the report.

In order to secure accurately collected specimens passed by normal pregnant women living under uniform physical conditions an attempt was made to hospitalize an adequate number of such individuals. Failing to secure a sufficient number of normal subjects, it was found necessary to utilize other hospitalized patients, who exhibited mild or moderately severe complications of pregnancy (Table I). All but 2 of the 24 patients were in the middle or last third of gestation (Table II) and all but one were confined to bed on the day that their urine was being collected.

First, a 24 hour specimen was collected from each of the 24 individuals, when on a normal fluid intake measurement of the hormone in these specimens supplied data on the limits of its excretion. On the following day 6 of the 24 patients gave a second 24 hour specimen, which was much larger than the

first one due to a forced ingestion of fluids. A comparison of these specimens with the first ones, formed the basis for observations on the influence of urine output on hormone excretion.

Preparation of urine. Each 24 hour specimen of urine was measured, and a sample retained for analysis. A 30 cubic centimeter portion was chilled, acidulated slightly with acetic acid if alkaline, and filtered. It was then well shaken with five volumes of absolute alcohol and the mixture was permitted to stand in the ice box over night. The material was centrifugated, and the supernatant liquid poured off the residue was air dried and put into normal salt solution the latter equal in amount to one half of the original volume of chilled urine. This extract was employed as the source for the hormone.

Preparation of animals. Adult female rabbits in the estrous stage, were used for all tests. In order to assure a suitable degree of heat, each animal was permitted to cast a litter being caged alone from the date of the last successful mating until the end of the experiment. The litter was removed the day of birth and the animal used for test shortly thereafter.

Hormone unit and method of measurement. The amount of hormone is expressed in rabbit units (Rb U). A rabbit unit is defined as that quantity of hormone present in the smallest amount of urine which, on intravenous injection into an estrous rabbit, will be followed by rupture of at least one follicle. In order to discover this amount of urine a series of rabbits, one animal a day received graduated intravenous injections of the urine extract until the *maximum non-effective* and *minimum effective* doses were determined. An arbitrary dose was given to the first animal of each series. If follicular rupture was not observed at operation or at necropsy 20 to 24 hours

¹Friedman, M. H. Mechanism of ovulation in rabbits: ovulation produced by injection of urine from pregnant women. *Am. J. Physiol.*, 1939, 32, 437-443.

TABLE I—HORMONE EXCRETION AND HEALTH

Recording (1) the amount of ovary stimulating hormone excreted in 24 hours by 24 pregnant women living under similar controlled physical conditions, and (2) the relation of the amount of hormone to the health of the patients. Note the large number of specimens (14 in 24) which contained less than 2,000 rabbit units of hormone and the fact that the normal patients, and most of the unhealthy ones excreted less than 7,000 rabbit units of hormone.

Thousand units of Rb.U.	Urine specimen No.	Health						
		Normal	Mild tox- emia	Threat- ened abortion	Pre- eclampsia	Diabetes	Cardiac disease	Under- treated
0-1	8	5	1				1	
1-2	6		4	1	1			
2-3	3						1	1
3-4	1			1				
4-5	1				1			
5-6	2	2						
6-7	1	1						
7-8	1					1		
8-9	0							
9-1	0							
10-11	1			1				
11-12	0							
12-13	1					1		
Total	24	8	5	4	2	2	2	1

later, the next animal received twice the preceding dose. If the first dose was effective the following dose was reduced to one half of the former one. This dosage ratio was employed in all cases, except where amounts of extract exceeding 1 cubic centimeter were necessary. Here the increase of dosage was sometimes less than twice the preceding one. The amount of urine containing 1 rabbit unit is defined as that quantity midway between the maximum and minimum doses described. With this amount of urine determined, the hormone content of the 24 hour specimen was computed.

RESULTS

The amount of hormone excreted in 24 hours
The amount of hormone excreted in 24 hours by 24 pregnant women living under controlled physical conditions and on a normal fluid intake, is recorded in Table I. Though the upper limit of excretion of hormone was in the neighborhood of 14,000 rabbit units more

TABLE II—DURATION OF PREGNANCY WHEN URINE WAS MEASURED

Duration of pregnancy days	Number of patients
0-90	3
91-180	8
181-280	20

TABLE III—RELATION OF OUTPUT OF URINE TO EXCRETION OF HORMONE

Showing the number of rabbit units of ovary stimulating hormone found in two 24 hour specimens of urine passed by each of 6 pregnant women on succeeding days, the first specimen (A) resulting from a normal intake of fluid, the second one (B) after a forced fluid ingestion. Note the relative constancy of hormone excretion on succeeding days, in spite of wide variation in output of urine.

Patients	Specimen	Urine	Hormone
		c.cm.	Rb.U.
1	A	2500	300
	B	3000	416
2	A	3000	600
	B	6000	375
3	A	2500	272
	B	3000	400
4	A	2150	416
	B	2700	337
5	A	650	1733
	B	2150	1500
6	A	780	105
	B	1400	111

than 58 per cent of the patients excreted less than 2,000 rabbit units.

Since most of the patients suffered from complications of pregnancy, and because little is known regarding the relation between them and the excretion of the hormone, their relation is shown in Table I. The normal patients and most of the unhealthy ones excreted less than 7,000 rabbit units.

Three of the pathological conditions are of interest—toxemia and abortion, because they are peculiar to pregnancy, and diabetes mellitus, because, in the specimens from the diabetic patients an unusually large amount of hormone was present (Table I). Since the amounts of hormone in the first two conditions were not unusual, it appears unlikely that such complicating conditions influence the rate of excretion of the hormone. Whether the presence of diabetes mellitus is related directly to the large amount of hormone, which 2 patients having this disease excreted, requires further investigation.

The relation of output of urine to excretion of hormone Two 24 hour samples of urine passed on succeeding days were collected from 6 individuals. In each instance the first sample was the smaller and resulted from a normal intake of fluid the second larger specimen followed a forced ingestion of fluid. In each case the 2 specimens varied approximately 100 per cent or more in size (Table III) whereas the amounts of hormone which each contained were about equal. From a comparison of the figures in this table, it appears that the excretion of hormone by the same individual on succeeding days does not increase with increase in the output of urine, but remains constant. In fact, from a study of these cases, and of 4 which are not recorded, an increase in the output of urine not only was not associated with an increase in the amount of hormone which was excreted but, if any relation between the two does exist an increased output of urine was usually associated with a decrease in the excretion of hormone the latter result however is believed to be more apparent than real.

Deductions The number of observations in this study is small and the patients who supplied urine specimens were not all healthy, nor were they in the same state of pregnancy. Also the number of animals for use was limited. Nevertheless the results seem to be significant.

It is apparent that the excretion of the hormone is independent of the output of urine that an increase in the latter has no tendency to wash an additional amount of hormone out of the body. In fact, the reverse may be true. This latter point needs further investigation.

Because the excretion of hormone is constant and the output of urine normally is variable, it follows that the concentration of hormone must vary from sample to sample of urine. Consequently the excretion of hormone cannot be expressed accurately if at all, in terms of urine output. It is evident therefore that the amount of hormone which is excreted must be measured directly and should represent the amount passed in a suitable period of time in order not to reflect marked alteration upon it by changed physical

conditions. For such a measurement, the 24 hour specimen seems most suitable.

The present method of measuring the amount of hormone in the urine is more accurate than other biological ones³ but like them, possesses too many disadvantages to make it suitable for clinical purposes, though it will continue to have value as a research method. The expense of maintaining a large colony of animals and the time consumed in securing an adequate number of animals in a suitable degree of heat are two of the chief disadvantages of such a procedure. These combined with death of animals shortly after injection and the wide variation in the amounts of hormone in the different specimens of urine, which necessitated many unsuccessful measurements before the desired determinations were secured, greatly prolonged the period of the present study.

In spite of these difficulties, additional quantitative estimations of the hormone either in the urine or blood or in both should be carried out, and the normal limits be clearly established, after which the amount in pathological states should be estimated. By such studies light may be thrown on the causes of some of the pathological conditions peculiar to pregnancy as well as upon the influence of these diseases on production and excretion of hormone.

SUMMARY AND CONCLUSIONS

1 The amount of ovary stimulating hormone (expressed in rabbit units) in 30 24 hour specimens of urine of 24 pregnant women is recorded.

2 Some patients were normal others exhibited mild complications of pregnancy the majority were in the last third of gestation when their urine was collected.

3 The amount of hormone excreted in 24 hours varied from less than 100 to more than 12,000 rabbit units the majority of patients voided less than 2,000 rabbit units.

4 The excretion of hormone by the same individual from day to day was relatively constant and was independent of the output of urine.

5 From these observations, it is concluded that

Idem. Personal communication.

a. Variation in the output of urine has no significant influence upon the amount of ovary stimulating hormone which is excreted

b. Estimation of the rate of excretion of ovary stimulating hormone, should be based upon measurement of the hormone in the

urine that is passed in a 24 hour period, and not upon the amount in a smaller sample of urine

The author is greatly indebted to Dr M. H. Friedman for suggestions and continued assistance throughout the period of investigation.

PROFOUND BLOOD PRESSURE FALL WITH BRADYCARDIA

A NORMAL PULSE RATE IN SURGICAL PROCEDURES¹

HUBERTA M. LIVINGSTONE, M.D. S. ELIZABETH McFETRIDGE, M.D., AND ROBBIE BRUNNFR, M.D.
CHICAGO

THE pulse is an important factor in determining the general condition of a patient undergoing a surgical procedure. Frequently the person delegated to observe changes in a patient is a nurse, a medical student, or an occasional practitioner whose interest is primarily in the operation. From observation, it appears that the pulse rate as an index of threatened collapse has frequently been overemphasized and that careful observation is not made of changes in the quality of the pulse. Macleod (1920) speaks of the pulse being rapid during surgical shock. Howell (1927) and Orr (1928) state that the low blood pressure that is characteristic of the condition of shock is associated with a very rapid rate of heart beat. Our data indicates that the pulse is not necessarily rapid during the condition of so called "surgical shock."

Many authors including Cannon (1923), agree that a state of so called "shock" may be said to exist when the systolic pressure falls to, and remains as low as 80 millimeters of mercury. Since the use of the sphygmomanometer during surgical procedures has not, as yet, become widely employed a proper interpretation of the pulse is even more important.

Observations including blood pressure and pulse changes have been made on 268 cases that presented during operation a systolic fall to 80 millimeters of mercury or less. The age incidence was fairly evenly distributed from 1 to 70 years. Three cases were over 70 years of age, 147 cases were male and 121 were female. Novocain, ethylene-oxygen, ethylene-oxygen

ether mixtures, ether, nitrous-oxygen gas, cocaine, and spinal anesthesia were the anesthetics employed, the last three agents being in the minority. A total of 4,410 operations are included in this series, 2,068 of which were major surgical procedures and 73 were double majors (operations lasting over 3.5 hours). Surgical procedures varied from minor operations as tonsillectomies to major intra abdominal and brain surgery.

In our series of 268 cases presenting a blood pressure below 80 millimeters mercury, 50 or 18.5 per cent did not exhibit a pulse rate above 100 per minute, 49 or 18.1 per cent, did not have a pulse rate above 120 per minute. In several cases the pulse did not become very compressible, weak and thready until some time after the blood pressure had reached an alarming level. The greatest age incidence of those not having a pulse rate above 100 per minute, but a low blood pressure, was from 30 to 70 years of age. Of the total cases studied 57 did not have a blood pressure below 80 millimeters of mercury but had a rapid pulse rate (above 120 per minute).

In a series of 12 anesthetized dogs in which death was brought about by hemorrhage one dog exhibited no increase in pulse rate, while two had an increase not to exceed 20 per minute (Fig. 1 and Table I). Dogs normally have an increased pulse rate associated with etherization. Following anesthetization, the 12 dogs observed had a minimum pulse rate of 170.

The early and correct interpretation of collapse during operation, and the resultant early

¹ From the Department of Surgery of The University of Chicago.

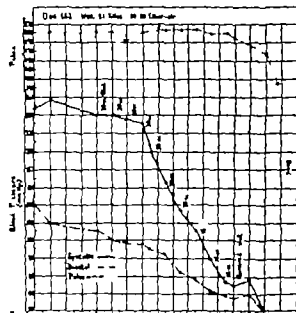


Fig. 1

administration of stimulants and intravenous normal salt Ringer's solution blood transfusion etc. play an important rôle in the post operative course. A survey of some of the surgical services during a specific period including a few case reports may demonstrate the importance of observing blood pressure and pulse quality changes rather than changes in pulse rate.

Table II presents the neurosurgical operations. Of the 108 intracranial cases 74 exhibited a systolic blood pressure of 80 or less. Nine or 12 per cent of these did not have a pulse rate above 120 per minute. Of the 83 encephalograms 9 had a systolic pressure of 80 or less. It is of interest to note that all of these 9 cases did not have a pulse rate above 100 per minute. Sixteen of the 31 spinal cord operations had a marked fall in blood pressure associated in 7 cases with a slow pulse rate. The following case report illustrates this group.

No. 7395. A woman 70 years of age, entered the hospital on February 9, 1930, complaining that she had had pain across her back and down her legs for 9 months. Physical examination revealed a large well preserved individual weighing 48.4 kilograms. The blood pressure was 170/105 although the heart sounds were regular in force and rhythm and without murmurs. A roentgenogram revealed a heart 18 per cent oversize with calcification of the abdominal

TABLE I.—DOG 663 WEIGHT 8.1 KILOGRAMS.
NO PREMEDICATION 50-50 ETHER AIR
ANÆSTHESIA HÆMORRHAGE

Time interval in minutes	Amount blood cc.	Blood pressure	Pulse
		120/80	100
0		120/80	100
1	30	90/60	100
2	30	70/50	100
	30	70/50	100
	30	60/40	100
	30	160/110	100
	30	130/80	100
	30	130/80	100
	30	100/70	100
	3	80/40	100
	3	50/30	100
1	1	50/30	90
	Removed clot	90/50	80
	None		70
	None		100
	Dog died		

TABLE II.—NEUROSURGICAL OPERATIONS

Operation	No.	Systolic BP 80 or less		Pulse 120 or less		Pulse 90 or less		Systolic BP above 120 rapid pulse	
		No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Intracranial	108	74	68	3	3	6	5.4	30	28
Ventricular punctures	23								
Encephalogram	83	9	10.8	6	7.2	3	3.6	None	
Retro-gram	9	3	33.3					None	
Spinal cord	31	16	51.6	1	3.2	6	19.4	None	

aorta. The lungs were clear although tuberculous glands were excised from the neck in July 1929. Blood examination revealed red blood cells, 4,800,000 hemoglobin 86 per cent white blood cells, 9,500 Wassermann and Kahn tests were negative. There was a considerable quantity of albumin in the urine. A pre-operative diagnosis of cord tumor was made.

On March 4, 1930, a laminectomy was performed. Ethylene-oxygen induction was followed by a 4½ ounce ether anesthesia. Ether vapor was administered intermittently because of a narrow anesthetic margin and a tendency to cyanosis. There was a thick mucous discharge from the upper respiratory tract which was removed with suction. During the last 40 minutes of the 1 hour operation, the blood pressure was 80 millimeters of mercury or less.

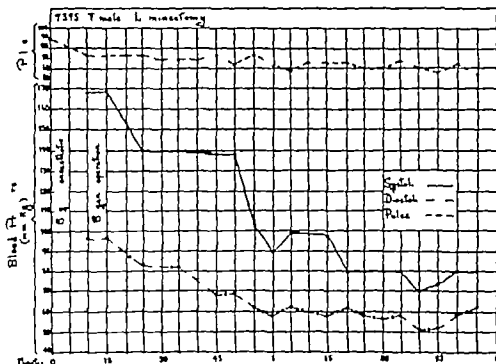


Fig. 2.

systolic (Fig. 2). The pulse throughout remained slow and regular, varying from 52 to 72 per minute. This patient required intensive intravenous therapy immediately after operation to bring the blood pressure and pulse quality back to a normal level. On March 8, 1930, the urine was normal and remained so throughout her stay in the hospital. She was discharged on May 23, 1930.

In 199 major upper abdominal operations, 31 or 15.5 per cent, exhibited a blood pressure below 80 systolic. Of these 8 or 25.6 per cent did not have a pulse rate above 100 per minute while 12 or 38.4 per cent did not have a pulse rate above 120 per minute. Of the 199 cases, 7 or 3.5 per cent did not have a blood pressure below 80 systolic, but had a rapid pulse (above 120 per minute). The marked blood pressure fall in this group usually occurred when the peritoneum was opened, or during traction or irritation of the upper abdominal viscera, especially in the liver or diaphragmatic area. This effect is in accordance with some phases of the work of Carlson and Luckhardt (1921) in frogs, and Scott and Ivy (1932) in frogs and dogs. Recovery usually occurred with lessening of the traction or trauma, or at least with peritoneal closure. Contrary to the observations of Crile (1903), who reports that the fall in blood pressure with upper abdominal manipulation is associated with a rapid pulse, we

found that the pulse rate usually remains low or even falls below normal. The following case report demonstrates this observation.

No. 36686. A housewife, aged 57 years, entered the University of Chicago Clinics on April 10, 1931, because of itching for 8 years, loss of weight for 6 months, diarrhea for 2 months, pain in the abdomen for 4 weeks, and jaundice for 1 month.

Physical examination revealed a well developed, short, obese woman weighing 85.8 kilograms and 145 centimeters in height. The heart was normal and the blood pressure was 136/73. The lungs presented slight decreased resonance at the right apex. Enlarged tonsils, extensive varicosities of the legs, a femoral hernia, as well as an apparent non-tender mass in the right upper quadrant were present. The sclera were yellow. Blood examination revealed red blood cells, 5,160,000; hemoglobin 90 per cent; white blood cells, 6,100. Wassermann, Kahn, and urine examination were negative. The pre-operative diagnosis was chronic cholecystitis and cholelithiasis.

On June 2, 1931, a cholecystectomy was performed under ether anesthesia following ethylene-oxygen induction. Eight ounces, open drop ether was administered. The anesthesia lasted 2 hours, during the last 1 hour and 35 minutes of which the blood pressure was below 80 systolic, although the pulse rate never exceeded 108 per minute (Fig. 3). The patient received 1 cubic centimeter of ephedrine (hypodermically) during operation and 2 cubic centimeters caffeine sodium benzoate (hypodermically) at the close of operation. She was hyperventilated for a short period with carbon dioxide 10 per cent oxygen 90 per cent before leaving the operating room.

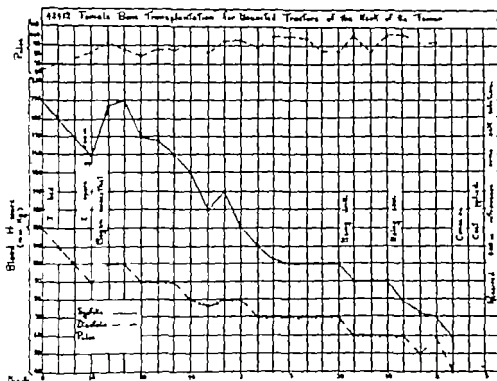


Fig. 5.

On July 16 1931, patient successfully underwent an operation under local anesthesia for the repair of the femoral hernia. Except for a pulse that was irregular in quality and rate the operation was uneventful. She was discharged in good condition on July 30, 1931.

De Lee (1928) states that in cases of ruptured ectopic pregnancy there usually is a low blood pressure and a fast pulse, but he has observed in a few cases a drop in blood pressure associated with a slow pulse rate—in 1 case 46 per minute.

In 213 major gynecological operations, 23 or 10.8 per cent had a low blood pressure. Of these, 8 or 34.7 per cent had a pulse rate below 100 per minute, while the same number had a pulse rate not to exceed 120 per minute. In the following case the steady fall in blood pressure is associated with a slow pulse rate.

No. 30174. A housekeeper aged 54 years, came to the University of Chicago Clinics on November 7, 1931, because of continued vaginal discharge and bleeding for 18 months and pain in the legs and back for 1 month.

Physical examination revealed a well developed woman weighing 49 kilograms. The heart was of normal size. The heart rate was slightly accelerated, but regular. The blood pressure was 148/104. The lungs were normal. Blood examination revealed red blood cells, 4,310,000; hemoglobin, 75 per cent; white blood cells, 13,350. The urine was normal. The

pre-operative diagnosis was suspected carcinoma of the corpus uteri.

On the day following admission because of a mild febrile reaction only a dilatation and curettage and examination were performed under a 20 minute ethylene-oxygen anesthesia.

Four days later (November 12, 1930) the febrile course had subsided so a total hysterectomy was performed. After a pre-operative 0.010 gram of morphine and 0.0004 gram of hyoscine ethylene-oxygen with the addition of $\frac{1}{4}$ ounce of ether was administered for 1 hour and 55 minutes. The blood loss was minimal. Following the removal of the uterus there was a noticeable drop in blood pressure, which 35 minutes later was 60/40 (Fig. 4). The pulse rate was 88 regular and of fair quality. The skin was warm and dry. Caffeine sodium benzoate (2 cubic centimeters) was given hypodermically however there was but a slight increase in the blood pressure. At the termination of the operation 35 minutes later the blood pressure was 70/58, the pulse rate 96 per minute and of only fair quality. The patient's body was still warm, but she responded slowly. One cubic centimeter of digifolin was given hypodermically.

Immediately upon returning to her room the patient was given 1 cubic centimeter digifolin, and 1 cubic centimeter ephedrine hypodermically and 1500 cubic centimeters Ringer's solution by hypodermoclysis. Patient was conscious. Thirty minutes later the blood pressure was 90/70 and the pulse was hardly perceptible. As the pulse remained weak 1 hour later 500 cubic centimeters of 10 per cent glucose were administered intravenously and the pulse became stronger. The pulse rate was 94 per minute and the blood pressure 100/70. Eight hours

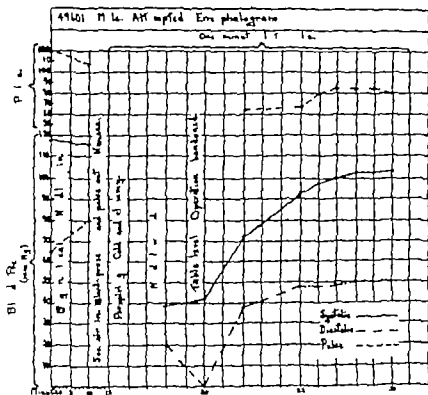


Fig. 5

later the blood pressure was 124/100 however the skin was cold and clammy and the pulse almost imperceptible. Codeine and alcohol were administered, but the patient did not sleep for 24 hours following operation. The day after operation 1500 cubic centimeters of subcutaneous Ringer's solution were administered as the patient seemed dehydrated. The pulse was now of good quality and the patient made an uneventful recovery.

In 115 bladder and prostate operations 8 or 6.9 per cent had a blood pressure below 80 systolic. All of these 8 patients had an associated slow pulse rate it being below 100 per minute in 6 instances. This group consisted of individuals from 50 to 70 years of age. All presented a moderate to an advanced degree of arteriosclerosis.

Only 3 of 26 kidney operations were associated with a marked fall in blood pressure. Two of these 3 also had a slow pulse.

Table III presents cases not previously discussed and illustrates the frequency with which a low blood pressure was associated with a slow pulse rate.

Wiggers (1923) states that the arterial blood pressure fall in hemorrhage is associated with a rapid pulse. Although we found hemorrhage to be frequently associated with a blood pressure fall and pulse rise, we have noted several instances where the blood pressure fall is not associated with a pulse rise. Figure 5 illustrates the reaction to hemorrhage in a woman 54 years of age undergoing open reduction and fixation with bone transplantation for ununited fracture of the neck of the femur under ethylene-oxygen anesthesia, preceded by morphine sulphate gram 0.010 and atropine sulphate gram 0.0004. The patient required 1500 cubic centimeters normal salt solution intravenously in the operating room following operation to bring her blood pressure and general condition back to a satisfactory level. Preceding operation this patient had a blood pressure of 188/120. For the first week following operation the highest blood pressure reading was 120/78. The postoperative pulse was normal.

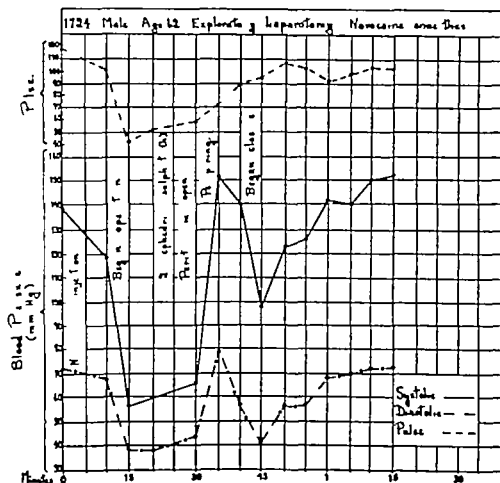


Fig. 7

Does general anaesthesia remove the changes in blood pressure and pulse rate produced by the fear of the operation or the anaesthesia? Toxic thyroids usually develop a more stable blood pressure and pulse after the induction of general (ethylene-oxygen) anaesthesia. Fear may cause either a rise or a fall in blood pressure with usually an associated rise in pulse rate.

The blood pressure fall that occasionally occurs under local anaesthesia may be attributed to a toxic reaction from the anaesthetic agent employed. According to Eggleston and Hatcher (1919) intravenous administration in cats of toxic doses of cocaine and procaine produces an abrupt fall of blood pressure with a slow heart usually, due to weakening of the heart muscle. They also report one case of intoxication in a woman following novocain injection, with the development of clonic convulsions and slowing of the pulse 8 minutes later. We have never observed convulsive phenomena.

TABLE III

Operations	No.	BP below 80 (Per cent of total)		BP 80 or less pulse 100 or less		BP 80 or less pulse 120 or less		BP above 80 pulse above 120	
		Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent
Lower Abdomen									
Gynecology	114	23	20	8	7	8	7	4	3
Bowel resection	5	1	20	1	20	0	0	4	80
Abdominoperineal resection	15	9	60	0	0	0	0	1	6
Miscellaneous	150	3	2	0	0	1	0	1	0
Ventral hernia	10	3	30	1	10	1	10	0	0
General surgical bone cases	445	68	15	7	1	6	1	30	6
Extremity amputation	3	1	33	0	0	0	0	1	33
Breast amputation	36	5	13	8	22	0	0	0	0
Sarcomata	45	8	17	6	13	8	17	1	2
Thyroid	41	8	19	8	19	0	0	4	9

The possibility of a fainting or psychic reaction has to be excluded. We have observed a

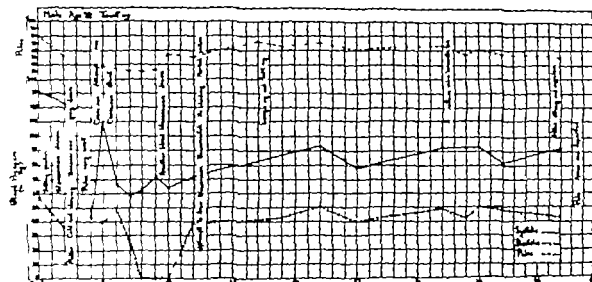


Fig. 6.

slowing in pulse rate associated with a rapid fall in blood pressure both in patients under local anesthesia and in very apprehensive or fainting individuals where no anesthetic agent is employed.

The manifestations mentioned of a slowing in pulse rate associated with a marked drop in blood pressure occurred in patients in both the upright and recumbent positions. Figure 6 illustrates the slowing and weakening of the pulse until it was imperceptible associated with a marked fall in blood pressure 5 minutes after novocain infiltration for an attempted encephalogram. Nausea, pallor, and cold clammy perspiration were associated with the pulse and blood pressure changes. A comparable picture was seen in a brief study made of tonsillectomies under cocaine anesthesia. The sitting position was employed in these two types of surgery. The same reactions have been observed in patients in the recumbent position under novocain anesthesia (Fig. 7).

In order to eliminate the possibility of a toxic reaction from the anesthetic agent employed, studies of the blood pressure and pulse changes during the drawing of blood for Wassermann and Kahn tests were made. Of 44 cases studied, 5 had a marked drop in blood pressure and a slowing of the pulse rate, and one patient lost consciousness. The rapid blood pressure fall that occurs with syncope has been reported (Tocantins 1930). Figure 8

illustrates not only the loss of blood pressure sounds with a loss of consciousness in fainting but also the slowing to loss of pulse beat. Upon the return to consciousness there was a rapid return of blood pressure and a slow increase in pulse rate. Forty minutes later neither pulse nor blood pressure had reached a normal level.

A blood pressure fall was observed in a patient 18 years of age during the excision of a sinus of the buttocks. No anesthetic agent was employed because of the presence of sacral anesthesia resulting from a spina bifida.

It is of interest to note the changes in pulse and blood pressure associated with the use of a constrictor. The application of the constrictor usually does not produce much change in blood pressure. There may be some rise especially if the patient is not entirely anesthetized. Operation on the bloodless area, as for osteomyelitis in adults, usually does not cause a blood pressure fall. In children, a very gradual fall may occur. After removal of the constrictor in a small number there is no change in blood pressure and pulse. Of 75 cases 65 had a fall in blood pressure. Of these 37 had a fall in pulse rate, 27 had no change in pulse rate, while 10 had a pulse rise.

DEDUCTIONS

Frequent instances have been presented where the drop in blood pressure has been our earliest warning of a change in the patient's

general condition. This suggests the importance of the more frequent employment of blood pressure observations during surgical procedures to enable us to institute earlier restorative measures. The time factor is of great importance as regards improvement in the patient's general condition when the need arises for stimulants, intravenous fluids and blood transfusion. The rapid improvement following the timely administration of a blood transfusion is noteworthy. It is apparent that changes in the quality of the pulse must be carefully observed as well as changes in the pulse rate.

SUMMARY

A marked blood pressure fall may occur without an increase in pulse rate.

A patient's condition may reach an alarming level some time before an increase in pulse rate occurs.

Blood pressure changes rather than an increase in pulse rate frequently present the earliest evidence of circulatory failure.

NOTE.—This work was done under the direction of Professors D. F. Henderson and Edmund Andrews, whom the writer wishes to thank for their many helpful suggestions.

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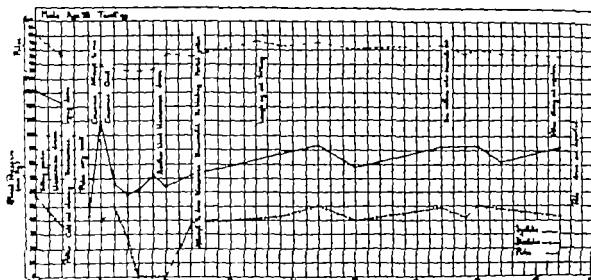


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Fig. 2. Gastric erosion

Sections of resected stomachs taken beyond the ulcer proper show in most cases evidence of gastritis with hyperacidity, gastric erosion and a marked increase in number and size of follicles (Fig. 2). Therefore because of this abnormal change in the gastric mucosa, resection is considered the best form of treatment.

In many cases of early gastric cancer diagnosis as such cannot be made until after operation. Pommershiem of this clinic found 47 cases of carcinoma superimposed on old calloused ulcers in a total of 530 patients examined or about 9 per cent.

TABLE I—POMMERSHIEM'S STATISTICS

	Per cent
Ulcer associated with gastritis	
Hypertrophic	46
Atrophic	40
Mixed	3
Site of ulcer	
Lesser curvature	46
Prepyloric	28
Pyloric	26
Depth of ulcer	
Submucous	5
Calloused	72
Penetrating	23
Microscopic appearance of ulcer	
Carcinoma solidum	40
Adenomatous	57
Fibrous	3
Type of ulcer	
Single	92.5
Duplicate	3.5
Triplicate	5



Fig. 3. Papillary degeneration old calloused ulcer. Precancerous lesion.

Clairmont states that about 10 per cent of calloused gastric ulcers become malignant but that 50 per cent of those which are prepyloric have a predisposition to malignancy. A. J. Walton believes that 10 per cent of gastric ulcers become malignant, Maresch considers the incidence to be between 10 to 15 per cent. Accepting as a fact that a certain percentage of gastric ulcers become malignant, resection offers the best chance of cure (Figs. 3 to 8).

Figure 3 shows a gross section of an old calloused ulcer at the precancerous stage. There is a decided papillary overgrowth and Figure 4 (microscopic section) shows the earliest change which we can regard as beginning cancer. A further advanced lesion is seen in Figure 5 also with history of a long standing ulcer on the lesser



Fig. 4. Microscopic appearance of preceding ulcer



Fig. 5. Carcinoma of lesser curvature

curvature. Figure 6 shows the gross, and Figure 7 the microscopic appearance of the ulcer with definite carcinomatous change. Both of these cases were diagnosed by X ray examination as



Fig. 7. Carcinomatous ulcer. Microscopic appearance of preceding ulcer



Fig. 6. Carcinomatous ulcer. X ray diagnosis of ulcer of lesser curvature 6 years before operation, medical treatment in interval.

ulcer of the lesser curvature 5 and 6 years previous to operation. A further similarity between the papillary degeneration of an old ulcer and cancer is demonstrated in Figures 8 and 9.

The detailed technique of Professor Verébely's method of stomach resection was first reported in 1927 by Neuber. He reported results on 226 cases operated upon up to that time. To review briefly without a detailed report as to pre-operative care, anesthesia, and step by step procedure, I will mention only the general principles which are embodied in this method:

1. Application of the sewing clamp to the stomach after ligation of the vessels (Figs. 10A and 10B)

2. Incision between two rows of metal sutures preventing escape of any gastric content (Fig. 11)

3. Removal of stomach and portion of duodenum (containing ulcer when possible)¹

4. Closure of duodenum—continuous catgut for the muscularis and mucosa, and interrupted sutures for the serosa.

5. Anastomosis between stomach and jejunum, the lower corner of stomach is resected, suture line fixed below and through mesocolon (Fig. 12).

The operation is performed under local anesthesia—usually, splanchnic anesthesia is employed though spinal and infiltration methods have also been used.

After this method of resection, all patients are sent to the X ray laboratory for fluoroscopic examination on the eighth or tenth postoperative day. Dr. Ratkoczy, director, has found that there is no precipitate emptying of the stomach.

¹ When it is not possible to excise duodenum below ulcer the method of J. J. Macfarlane is followed, resection by exclusion of the ulcer.



Fig. 8. Papillary degeneration of gastric mucosa



Fig. 9. Papillary carcinoma

The metal sutures have in no case caused any difficulty, they usually slough out and are passed by bowel in 2 or 3 weeks.

The mortality for all cases following gastric resection was 7.8 per cent following gastro-enterostomy, 3.5 per cent. Since 1923, the corner anastomosis of Professor Verebely has been exclusively followed and the mortality has been lowered to 4.8 per cent. This is inclusive for all resections, for carcinoma perforated ulcers, etc. In operation for peptic ulcer alone the mortality was 4.5 per cent following gastro-enterostomy, 1.8 per cent after exclusion of pylorus and gastro-enterostomy, and now 0.5 per cent after resection with the use of the sewing clamp and corner anastomosis.

Any method of treatment can be fairly judged not alone on the mortality statistics but by the

end results obtained especially if the method has been used in a large number of cases over a long period of time and the follow up shows continued good results. Since 1923 a careful postoperative check up has been made on all patients on whom resections were performed. Previous to that time postoperative records on ulcer and cancer patients operated upon had been kept but the data were not as complete. The sum total of all resections performed has shown good results in 81.4 per cent of the cases, or 1,954 fair results 16.6 per cent, or 398 cases bad results 2 per cent, or 48 cases.

After palliative operations—exclusion with gastro-enterostomy etc.—we found good results in 49 per cent, fair results in 33 per cent and bad results in 18 per cent.

After resection with corner anastomosis accord-

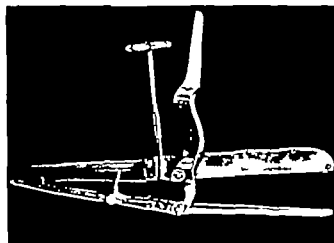


Fig. 10. A, Sewing clamp to be applied to stomach. B Application of sewing clamp to stomach (from movie film)



Fig. 10. Stomach incised between two rows of metal sutures.

ing to Professor Verebely good results were obtained in 90 per cent fair results in 8.5 per cent poor results in 1.5 per cent.

CONCLUSION

A method of treatment is reviewed and the results after a 9 year period have been summarized and have been found to be more satisfactory both in regard to mortality and permanency than are the results from any of the other methods of treatment.



Fig. 11. Corner of stomach to be resected followed by anastomosis to jejunum.

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OVARIAN TUMORS OF THYROID TISSUE

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ACCESSORY thyroid glands or aberrant nodules of thyroid tissue are found comparatively frequently in the neck base of the tongue and structures of the thorax. Also cell masses identifiable as thyroid tissue are not infrequently noted in ovarian dermoid cysts or teratomata (19 per cent according to Kouchs). But isolated nodules of thyroid tissue in the ovary unassociated with other heterotopic tissues are so rarely seen that their occurrence deserves to be recorded.

The significance of thyroid tissue in the ovary in which thyroid structures make up practically all of the tumor has been widely considered. Gottschalk, in 1899, described a tumor of the ovary which he believed had arisen from malignant change in a graafian follicle. His description corresponded to that of a tumor of thyroid tissue but he called it *folliculoma malignum ovarii*. Kretschmar in 1901 reported a similar tumor in which he believed he could demonstrate the primary tumor elements arising from the lining cells of a lymph space. He therefore, designated the tumor an *endothelioma*. Katsurada also in 1901 described briefly a teratoma containing thyroid tissue. The following year Pick presented before the *Berliner medizinische Gesellschaft* a series of 21 dermoid tumors of the ovary 7 of which contained thyroid tissue. His evidence was convincing that the thyroid tissue in these tumors was part of a teratomatous growth in which the endodermal elements of thyroid anlage had undergone excessive development with partial or complete suppression of other tissue elements. He placed the cases of Gottschalk and Kretschmar in the same category. This gave rise to a series of heated arguments before this society. Kretschmar later admitted that his tumor consisted of thyroid tissue but he believed that it had metastasized in spite of the fact that a few small areas of bony tissue were found. He explained these on the basis of metaplasia of the connective tissue. Following Pick's intensive study of this type of tumor and of teratomata in general, numerous studies were reported from various countries. Most observers supported the teratomatous origin of these tumors. Walthard made serial sections of three ovarian tumors which

grossly seemed to consist only of thyroid tissue. In one of these he found a small cartilaginous mass, and in another a small area of squamous epithelium and sebaceous and sweat glands. The third and largest tumor consisted of thyroid tissue except for a little ovarian stroma in the capsule. This work gave material support to Pick's hypothesis. Saxer about the same time contributed additional evidence by describing his frequently quoted case the ovary of which was entirely normal except for the inclusion of a single tooth thus a dental anlage had developed with suppression of all other types of tissue.

Bauer and Borst, among others have refuted the teratomatous origin of these tumors. Bauer demonstrated a transition from a typical papillary cystadenoma into thyroid like tissue and stated his belief that most so called tumors of thyroid tissue of the ovary are atypical cystadenomata. Borst presented the view that a follicular adenoma might give rise to thyroid characteristics and have nothing to do with a teratoma. In this regard the view of Ribbert may be recalled that cystadenomata of the ovary are teratomatous in origin having an endodermal anlage and are therefore frequently associated with dermoid cysts. Bell did not accept this view since he believes that the thyroid like tumors arise from a peculiar colloid degeneration of cystadenomata. Strong is inclined to agree with this view except in rare instances. However most observers agree with Pick that these tumors are of teratomatous origin.

To the clinician the most interesting feature of this type of tumor is its capacity for secreting thyroxin. Certainly in most of the cases reported the presence of hyperthyroidism was not mentioned. Frankl explained this lack of physiological function on the basis of a relatively meager intracinar blood supply. The presumable thyroid secretion is thus not adequately absorbed into the blood stream. A few cases have been reported, however, in which some physiological effect was believed to have been demonstrated. Kovács reported the case of a woman aged 33 years who had an enlarged thyroid gland and mild symptoms of hyperthyroidism. A tumor of thyroid tissue was removed from the ovary. Nine months



Fig. Ovarian tumor removed at operation. Some of the large peripheral cysts have collapsed but the colloid of the central portions is preserved. The mass measured 14 by 8 by 7 centimeters, and weighed 250 grams. Case 1.

after operation the symptoms of hyperthyroidism had improved. Trapl reported a case in which hyperthyroidism developed after removal of a thyroid tumor from the ovary. He explained this phenomenon as compensatory hyperfunction of the thyroid gland. In a case reported by Moench, a cardiac irregularity which had been considered functional, cleared up after removal of a cyst from the right ovary which was found to contain thyroid tissue. Moegan presented a necropsy report in which a markedly atrophic thyroid gland was associated with a tumor of the left ovary. He believed that the teratomatous thyroid tissue was compensating for the atrophic thyroid gland. Outerbridge after reviewing all the reported cases, came to the conclusion that the aberrant thyroid tissue has little if any functional significance. It is with this question of functional activity in mind that the following cases are presented.

REPORT OF CASES

CASE 1—A woman, aged 40 years, first came to the clinic September 13, 1929. At this time she gave a history of mild hyperthyroidism. Her highest basal metabolic rate was +15, and the pulse rate was consistently around 100 beats each minute. A pelvic tumor was also noted. She was advised to have thyroidectomy first, and later to have the tumor in the pelvis removed.

September 30, subtotal thyroidectomy was performed with double resection and removal of the lithemia. The pathologist reported hemorrhagic cystic degenerating colloid and fetal adenoma in a colloid thyroid gland. The tissue removed weighed 36 grams. Recovery was uneventful. October 16, left oophorectomy was performed for multilocular cystic tumor of the left ovary. The pathologist reported that the tumor (Figs. 1 and 2) consisted of hemorrhagic, fibrous, hyaline, cystic, degenerating colloid and fetal thyroid adenoma. At the time of the operation a great deal of milky ascitic fluid escaped from the abdomen.

The patient was discharged in fair condition 19 days after the operation. The final basal metabolic rate after the two operations was —4.

The patient returned December 11, 1929, with marked anasarca which had gradually developed since she left the clinic in October. The only abnormality noted on examinations of the blood and urine was albumin, grade 1 in the urine. Paracentesis was done with removal of 1,700 cubic centimeters of straw colored fluid. The edema was treated with salyrgan with good response.

Between December 11, 1929, and October 2, 1931 the patient returned to the clinic a number of times for paracentesis and study always with the same results, except that a renal stone and hematuria was discovered on one occasion. Roentgen rays were applied over the pelvis and abdomen without relief of anasarca. The patient's general condition remained good in spite of the fact that she had had paracentesis with removal of about 9,500 cubic centimeters of fluid every 10 days.

October 6, 1931 abdominal exploration was carried out. A large amount of ascitic fluid was evacuated, but no other abnormalities were noted. All peritoneal surfaces appeared normal. October 30, after dismissal from hospital, the patient began to complain of severe abdominal cramping, requiring morphine. Anasarca and cardiac embarrassment were noted. Her condition gradually became worse and the leucocyte count was high. Death occurred November 1.

Necropsy disclosed a remarkable state, apparently in no way related to the previous hyperthyroidism and ovarian tumor. In addition 10,000 cubic centimeters of ascitic fluid, there was complete thrombosis of the portal system. The thrombus was recent in the mesenteric veins, but old and well organized and partially canalized in the splenic vein. The left branch of the portal vein at the hilum of the liver was reduced to a fibrous band. The anasarca was apparently dependent on the thrombotic process which had suddenly increased, and ended fatally. No recurrence of tumor was noted in the pelvis, all peritoneal surfaces being smooth. Figure 3 shows the structure of the thyroid gland removed at necropsy.

On further study of the cystic ovarian tumor which was removed ovarian stroma was found only in its peripheral portions; this was infiltrated with lymphocytes. Most of the blocks, cut from various parts of the tumor contained areas structurally typical of adult thyroid tissue whereas (Fig. 3) in other areas were the small, closely packed acini seen in so called fetal adenoma. Here and there were areas of ordematous and degenerating hyaline stroma containing scattered small groups of thyroid-like acini. Teratomatous structures other than thyroid tissue were not found, except one small cystic space which was lined by an atypical stratified epithelium six to eight cells deep which may possibly have represented ectodermal elements.

The important question, which unfortunately can never be answered definitely is whether the patient's hyperthyroidism may not have been partially or completely due to the large mass of thyroid tissue in the left ovary. The weight of the mass, on removal, was 210 grams whereas the tissue removed from the thyroid gland weighed

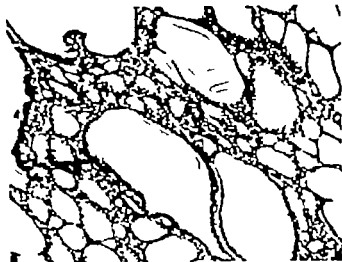


Fig. 2. Ovarian mass in which may be seen evidence of hyperplasia of the thyroid epithelium in some of the larger acini. Case 1.

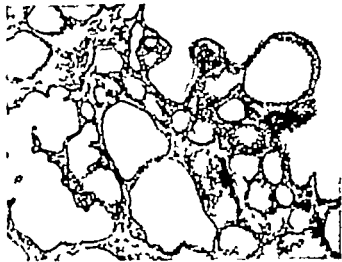


Fig. 3. Specimen of thyroid gland removed at necropsy (Fig. 2). Slight evidence of hyperplasia may be noted. Case 1.

only 36 grams. In the ovarian tumor occasional areas of hyperplasia were noted (Fig. 2). These were also present in the thyroid gland. It is unfortunate that basal metabolic rates were not taken in the interval between the two operations. The pulse curve after the two operations however affords some information. Seven days after the thyroidectomy (first operation) the pulse came down to 90 beats each minute. This was the lowest pulse rate recorded during that period in hospital. The patient was dismissed from the hospital on the eighth day with a pulse rate of 100. Following the removal of the thyroid tumor of the ovary the pulse rate was 70 on the fifth and sixth postoperative days and although it did not remain at this level it maintained a lower level than previously. The basal metabolic rate after both operations was -4 but this is of no assistance in answering the question. The subsequent events with the rapid reaccumulation of ascites over a period of 2 years, were probably in no way related to the hyperthyroidism but were no doubt due to portal thrombosis. The basal metabolic rate reported 10 days before death was -4 .

CASE 2. A woman aged 55 years, presented herself at the clinic November 4, 1927, with a history of swelling of the abdomen for 4 months which began following an attack of severe pain in the region of the urinary bladder. The abdomen had been tapped three times before admission with removal of about 9,500 to 11,000 cubic centimeters of fluid each time. She had lost more than 15 pounds in weight during her illness and felt weak, and her appetite was poor. She had passed through a normal menopause at the age of 45 years. There had been no pelvic symptoms until the onset of the present illness when suprapubic pain developed.

On examination, evidence of loss of weight was most apparent about the face, neck, and arms. The thyroid gland

was normal to palpation. The heart was normal except for a rapid rate which varied between 80 and 110 before operation. The abdomen was markedly distended with fluid so that organs could not be felt. Pelvic examination likewise was negative. Roentgenograms of the abdomen and thorax study of chemical changes in the blood as well as tests of hepatic function all proved to be within normal limits. Achlorhydria was the only abnormal laboratory finding. The basal metabolic rate was not taken. Diuretic response to salyrgan and ammonium nitrate was very slow.

Abdominal exploration was performed November 16 with the withdrawal of a large amount of clear fluid. The liver was normal to palpation, as was the peritoneum. There was a tumor of the right ovary which was somewhat adherent with considerable inflammatory reaction in the cul-de-sac, but without evidences of malignancy. The tumor was removed, without disturbing the uterus and left ovary. Pathological examination revealed the right ovary to be replaced by a cystic mass weighing 45 grams. It contained a fibroma and tissue which grossly and microscopically resembled adult and fetal thyroid tissue with areas of undifferentiated fetal thyroid tissue (Fig. 4). Certain alveoli showed papillary projections covered with cuboidal or columnar epithelium and typical hyperplasia. In only one area was there any tissue suggestive of ovarian stroma and this was without follicles.

The patient recovered rather slowly but steadily and there was no tendency to reaccumulation of fluid. The tendency toward tachycardia continued, although the pulse rate seldom was more than 100 after operation. Compound solution of iodine 30 minims was given for 4 days after operation, and again before the patient left the hospital. Two basal metabolic rates, taken on the thirteenth and twentieth days after operation were $+32$ and $+50$ respectively. However neither of these determinations was considered satisfactory by the technicians. The patient manifested few symptoms of hyperthyroidism, although she was nervous and "jumpy" and the pulse rate was usually above normal. The weight, after operation, with the loss of fluid, was 58 pounds less than the normal weight of 193 pounds. The patient was dismissed feeling well 25 days after operation. She was heard from numerous times until June, 1930, which was 2½ years after operation and each of these times she reported that her condition was excellent.



Fig. 4. Frozen section from ovarian tumor. Although this is a thick section, the epithelium may be seen in folds typical of hyperplasia, in the larger acini. Case 3.

Although we have no absolute evidence of hyperthyroidism in this case, we made several suggestive observations most important of which are tachycardia, marked nervousness, and loss of weight. It is unfortunate that the basal metabolic rate was not taken before operation. Although the two rates taken after operation were not entirely satisfactory, it is probable that the rate was somewhat elevated at that time. The rapid accumulation of ascitic fluid was an interesting feature in this case. Although ascites occurs commonly with malignant ovarian tumors, its occurrence with benign tumors of the ovary is not common. It is said to occur in 7 to 8 per cent of ovarian cystomata, however, and it is possible that the peritoneal irritation produced by the tumors causes the outpouring of fluid. This is a possible explanation in this case, since there was considerable inflammatory reaction in the pelvis about the tumor.

CASE 3. A woman, aged 63 years, came to the clinic October 24, 1916, because of constipation. She had always been nervous, and had had a rapid heart beat with slight tremor which had not been progressive.

Examination revealed a pulse rate of 14 beats each minute; the blood pressure in millimeters of mercury was 160 systolic and 60 diastolic. The heart was enlarged slightly to the left. A coarse tremor of the hands was present, which could be partially controlled voluntarily. In the pelvis a firm nodular mass was felt to the right and posterior to the fundus of the uterus.

Subtotal abdominal hysterectomy was performed with removal of both ovaries and fallopian tubes. The pathologist found that the right ovary had been replaced by a mass of vascular tissue 7 by 6 by 5 centimeters. The cut surface was honeycombed with multiple tiny cysts filled with a colloid substance, and some very firm central masses. On microscopic examination, the mass resembled thyroid tissue both of the fetal and adult types with slight evidences of

hyperplasia. The firm central masses were made up of degenerated material containing coarsely granular calcium masses. Ovarian tissue was not identified.

It is unfortunate that metabolic studies were not made in this case, but with some evidences of hyperplasia of the thyroid tissue in the tumor it is possible that mild hyperthyroidism was present, as evidenced by the tachycardia. The nervousness may have been significant, the tremor of the hands which was partially voluntarily controlled, may also have been partly on a hyperthyroid basis. We have no data on the subsequent course of the case.

CASE 4. A woman, aged 30 years, first came to the clinic December 20, 1920, at which time a diagnosis was made of tuberculous of the third and fourth lumbar vertebrae, adenomatous thyroid gland, without evidences of hyperthyroidism, and a left ovarian tumor which apparently was not causing symptoms after treatment of the spinal column. She was advised to return in 3 months but she did not return until November 8, 1920, when she gave a history of metrorrhagia for 5 months. The adenoma of the thyroid gland was still present, but without apparent symptoms of hyperthyroidism. The tuberculous lesion of the lumbar vertebrae was well healed. The cervix uteri was markedly eroded and cystic, the fundus was somewhat enlarged, and the mass in the left ovary was estimated to be of about the same size as on the previous examination. Dilatation and curettage of the uterus revealed hypertrophic endometritis. The cervix was cauterized. On examination of the pelvis under anesthesia, further operation was not deemed advisable.

September 28, 1931, the patient returned to the clinic with a history of bloating of the abdomen which had been constant for the last 3 to 5 months. She had gradually gained weight, from 185 to 202 pounds, and noticed a dragging sensation in the pelvis. Examination revealed well marked ascites in addition to obesity and a tumor in left side of the pelvis. A multilocular cyst of the left ovary was removed and a large quantity of ascitic fluid was drained from the peritoneal cavity. The left ovary was found to be replaced by a large multilocular cyst which measured 12 by 9 by 8 centimeters. The largest cyst contained hemorrhagic material adherent to its wall. The other cysts were smaller, and minute honeycombed cysts made up a large part of the mass. Sections taken from numerous areas of the mass showed groups of variously sized alveoli lined with flat or cuboidal epithelial cells, typical of thyroid tissue (Fig. 5). Masses of small cysts made up the walls of the larger cysts. All were filled with rather deeply staining colloid. Many areas gave the appearance of fetal thyroid tissue whereas others appear definitely hyperplastic. A fairly large irregular mass of polygonal cells with deeply stained nuclei surrounded and penetrated by blood filled spaces, was present in one section (Fig. 6). Here and there was a suggestion of alveolar arrangement. These cells were suggestive of parathyroid structure, but this possibility cannot be proved.

Although this patient had an adenomatous goiter and a large amount of thyroid tissue in the ovary, many areas of which showed evidences of hyperplasia, clinical evidence of hyperthyroidism was not displayed. For this reason metabolic rates were not determined. One may speculate



Fig. 5. Typical thyroid structure in ovarian tumor. Hyperplasia is clearly shown in the papillary projections of columnar epithelium into the acinar spaces. Case 4.



Fig. 6. Mass of polygonal cells resembling parathyroid tissue. The grayish spaces are filled with erythrocytes. Case 4.

concerning the occurrence of cells similar to parathyroid cells but there is no means of proving the identity of this mass of tissue. We have found reference to a similar type of tumor in the literature. Moench found masses of cells which closely resembled parathyroid cells in a tumor of thyroid tissue of the ovary. This case is included because of the nature of the tumor and the ascites without clinical hyperthyroidism in spite of definite hyperplasia of the thyroid epithelium in some areas.

CASE 5. A woman aged 38 years, first came to the clinic February 9, 1931. She had begun to have "heart trouble" in the autumn of 1930. In December she noted a swelling of the neck which increased rapidly. Later her voice changed and she had difficulty in talking. Dyspnea and occasionally stridor, dysphagia, weakness, nervousness, and loss of weight were among her complaints.

The patient appeared to be mentally dazed, stimulated and very weak. The pulse rate was 132 beats each minute the blood pressure in millimeters of mercury was 140 systolic and 70 diastolic. The basal metabolic rate was +82. The thyroid gland was enlarged bilaterally with bruit over all poles. Pelvic examination revealed a 3 to 4 months pregnancy. She was hospitalized but remained restless and irrational in spite of all treatment until February 15 when she became quiet and mentally more clear. Basal metabolic rate March 5 was +47. She was allowed to return home with instructions to take compound solution of iodine.

The patient returned April 14 with a basal metabolic rate of +73 per cent. Two injections of hot water were given into the thyroid gland, and April 24 the superior thyroid vessels on both sides were divided and ligated. Recovery was uneventful.

The patient returned October 19. She had had a premature delivery at home May 16 without complications. Her general condition had improved somewhat although weight continued to decrease. The thyroid gland was still large. The basal metabolic rate was +65 per cent, the blood pressure was 160 systolic and 88 diastolic. The pulse rate was 130. October 27 the right lobe of the thyroid gland was

resected. The pathologist reported a few small hemorrhagic, fibrous, cystic, degenerating colloid and fetal adenomata in a hypertrophic, parenchymatous gland. October 27 the patient's heart was fibrillating rapidly and she was irrational and coughing continuously. Pneumonia developed in the base of the left lung October 30 and death occurred 2 days later.

At postmortem examination, in addition to a large left lobe of the thyroid gland which still remained (weight 150 grams) and rather marked atrophy of the liver both grossly and microscopically, a rounded nodule was found buried in the right ovary. This measured 6 millimeters in diameter was dark red on its cut surface with a fibrous capsule surrounding it (Fig. 7). The ovary appeared otherwise normal except for numerous cortical cysts. The left ovary also contained numerous small cysts, but no similar nodules. Microscopic study of the nodule from the right ovary revealed a tumor made up of typical adult thyroid tissue containing a thin colloid substance. At one edge of the nodule definite evidences of hyperplasia were noted (Fig. 8). A fibrous capsule surrounded the nodule on all sides, cutting it off completely from the surrounding ovarian stroma. One small group of cells at the periphery adjacent to the capsule showed an atypical structure and remained unidentified, although the cells were suggestive of embryonic ependymal cells. The remainder of the thyroid gland (left lobe) was typical of the tissue under iodine treatment. The colloid was pale and few evidences of hyperplasia remained.

This case of frank hyperthyroidism is presented because of the small nodule of thyroid tissue in the right ovary. In this case there is no doubt that the hyperthyroidism was due to hyperplasia of the thyroid gland itself. The interesting feature is the fact that the small nodule of thyroid tissue in the ovary also presented evidences of hyperplasia. The ovarian nodule showed more evidences of hyperplasia than the original portions removed from the thyroid gland. An additional interesting point is the small size (6 millimeters) of the nodule.

CASE 6. A woman, aged 43 years, presented herself at the clinic July 15, 1924, because of nervousness and short



Fig. 7. Right ovary and tube. The ovary has been split longitudinally and laid open. The left on the cut surface may be seen dark rounded mass, which grossly and microscopically resembles thyroid tissue. Case 5.



Fig. 8. Thyroid nodule (Fig. 7). Epithelial hyperplasia in some of the larger acini, and ovarian stroma with follicular cysts at the upper border of the section may be seen. Case 5.

ness of breath which had been present for several years. She also complained of tachycardia and palpitation, and had noticed slight tremor of the hands. There had been no increased sweating, she felt chilly rather than warm.

On examination the patient appeared to be stimulated. The pulse rate was 100 beats each minute. Multiple adenomas of the thyroid gland, enlarged myomatous uterus and a tumor about 7 centimeters in diameter in the position of the right ovary were found. It was decided that hyperthyroidism was not present and the metabolic rate was not determined. Exploration of the pelvis was advised. It be followed in several weeks by thyroidectomy.

At operation a degenerating myoma of the uterus and a cystic tumor of the right ovary were found, and removed. Pathological examination showed the right ovary to be replaced by a cystic mass measuring 8 by 7 centimeters and having a thick wall and a fatty semisolid content without hair. Several small nodules were scattered over the inner surface of the cyst. These on cut surface were honeycombed with tiny cystic spaces filled with colloid material. Microscopic sections disclosed a thick, fibrous walled cyst lined by columnar epithelium in some areas, and broken up into irregular masses which were covered with columnar and cuboidal epithelium. The nodules mentioned were made up of thyroid like acini filled with colloid. Marked hyperplasia of the acinar epithelium was seen in irregular areas. The cells were cuboidal or columnar with large, centrally placed nuclei and the acini in these areas were closely crowded together and small. Infiltration of the interstitial tissues was not seen and few mitotic figures were present.

Symptoms of nervousness, palpitation and tachycardia suggested hyperthyroidism in this case but this was not substantiated by the entire clinical picture. The patient did not remain for the thyroidectomy and was never heard from subsequently, so we do not know if the symptoms improved. The interesting feature of this case is the presence of very marked hyperplasia of the thyroid tissue in the ovary. The greater part of

the tumor was made up of typical ovarian cyst adenoma with nodules of the hyperplastic thyroid tissue scattered throughout. It seems possible that slight hyperthyroidism existed. Photomicrographs of this tumor are not presented because of the poor fixation of the tissues.

GENERAL COMMENT

Although many of the cases reported in the literature are definitely not cases of hyperthyroidism there is present nevertheless a potentiality for excess secretion of thyroid tissue. But just as large adenomatous goiters may not produce symptoms of hyperthyroidism, so a mass of thyroid tissue in the ovary may be present without causing hyperthyroidism. The iodine content of these tumors has been determined quantitatively by Meyer King and Norris and others and it has been suggested that an appreciable amount of iodine speaks for functional activity of the tissue. Outerbridge determined the presence of iodine qualitatively by Jones differential staining method. Although iodine has been found in other organs such as muscles, suprarenal glands, thymus and spleen it is said by Crotti to be present in the thyroid gland in larger quantities than in any other organ except the parathyroid glands. The iodine content of the thyroid gland varies with the age of the patient, and also with the iodine content of the diet. Ordmann estimated the iodine content of the thyroid gland at approximately 0.1 per cent.

The iodine content of three of the tumors in this series was determined. The large tumor in Case 1 contained 0.105 per cent of iodine, dry weight.

The tumor in Case 4 contained 0.011 per cent of iodine dry weight and that in Case 3 contained 0.031 per cent dry weight. The tissues had been fixed in formalin solution and it is probable that a considerable proportion of the iodine had been dissolved by the solution. An appreciable amount of iodine was found in the three tumors examined; greatest in the case of the large tumor in Case 1. This patient had had mild hyperthyroidism and it is possible that the iodine she received accounts for the greater concentration of iodine in the tumor. In Cases 3 and 4 iodine had not been given. The thyroid tissue in the tumor in Case 3 contained the least amount of iodine and also the least hyperplasia of the epithelium.

The question of malignant change in these tumors has been of interest to the clinician and surgeon. Certain observers believe that tumors consisting entirely of thyroid tissue are all potentially malignant because they have overgrown all other tissue elements. From the cases reported in the literature as well as from our own cases there seems to be little evidence of malignancy. It is Ewing's belief that some solid carcinomata of the ovary may be derivatives of teratoid thyroid tissue. Certainly the majority of cases are neither clinically nor pathologically malignant. In Case 2 removal of the tumor afforded complete relief of all symptoms and ascites did not return. In Case 1, which later came to necropsy, there was no evidence of metastasis from the tumor, death having been due to diffuse venous thrombosis of the portal system and elsewhere. Similarly in many cases from the literature the patients recovered completely after removal of the tumor. However, a few definitely malignant cases have been reported by Katsurada, Norris, Proeschler and Roddy, Polano and others. Ulesko-Stroganowa reported the only bilateral tumor of thyroid tissue of the ovaries on record. Although histological evidences of malignancy were not present, she believed that the bilaterality of the tumor was evidence of metastasis from one ovary to the other.

The not infrequent occurrence of ascites with these tumors has been of clinical interest although apparently of no prognostic significance. In Cases 2 and 4 the ascites showed no tendency to recur after operation, whereas in Case 1 although the rapidly accumulating fluid was at first thought to be evidence of malignancy it could not be found at operation. This was later confirmed at necropsy. In Case 6 in which there was marked evidences of hyperplasia, ascites was not present. Frank has observed ascites in about 50 per cent of these tumors and cases without ascites have been

reported since he made this observation. His figure therefore seems far too high. Warren stated that 7.9 per cent of ovarian cystomata are associated with ascites and it would seem that similar causes probably operate to produce ascites with ovarian tumors of various types and that therefore this figure (7.9 per cent) is a better estimate than 50 per cent. The presence of ascites is obviously not necessarily indicative of malignancy.

SUMMARY AND CONCLUSIONS

Cases of ovarian tumor containing large amounts of thyroid tissue are presented. In one case the ovarian tumor contained nodules of hyperplastic thyroid tissue.

Tumors of thyroid tissue in the ovary are probably of the nature of teratomata.

Since these tumors are of thyroid tissue they are potential sources of thyroxin and in some cases seem to produce hyperthyroidism.

Three of the tumors were analyzed for iodine and an appreciable amount was found.

Hyperplasia of the thyroid epithelium in varying degrees is commonly observed in these tumors.

Malignant changes were not observed in the tumors reported in this series.

Ascites is not infrequently an accompaniment of these tumors.

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COMPOUND INTRA-UTERINE AND EXTRA-UTERINE (LITHOPEDION) PREGNANCY

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CALCIFIED fetuses or lithopedions have been recognized for centuries and have been reported from time to time in the literature. The earliest cases on record according to Dorland are those of Venetius 1505, Albosius 1597 and Densingeus 1661. In 1881 Kuechenmeister collected 45 cases of various forms of fetal calcification recorded during the 200 year period antedating 1880.

Lithopedions have occasionally been discovered during the performance of operations for various pelvic neoplasms and they are sometimes discovered accidentally at autopsy. In many instances it has been observed, that patients have successfully passed through one or more full term pregnancies, with birth of healthy children without the extrinsic gestation giving rise to difficulty.

In exceptional instances the presence of an extra uterine fetal mass is discovered during the course of a normal intra uterine gestation, as in the case recently reported by Balaban and as in the case presented in this paper.

In many of the cases recorded, the ectopic pregnancy has antedated the intra uterine impregnation by many years. As in the case history herewith presented patients are oftentimes entirely unaware of any abnormal abdominal condition, the extra uterine fetus not causing the mildest discomfort.

Since the publication of Kuechenmeister's exhaustive monograph on lithopedions a long list of cases of this rather extraordinary condition has been recorded in the literature.

Masson and Simon in 1928 assembled and published a summarization of the cases recorded from 1582 to 1926. This comprised in the aggregate 174 cases. To this number they added the records of nine lithopedions observed in the Mayo Clinic during a period of 24 years from 1903 to 1926, inclusive. The addition of these cases make a grand total up to 1926 of 183.

In a perusal of the literature since that date we found the records of 13 additional cases (Table I). These were not reported by the writers already mentioned nor had they been referred to subsequently as a collection. These cases with the one herein described make an aggregate of 197.

Here it may be of interest to mention that in 1906 one of us (Bland) reported a case of a mummified fetus which was carried by the patient for a period of 15 years. The structure was removed through an abdominal incision. Dissection of the mass after extirpation disclosed that it had probably reached the eighth month of development. During the 15 years the patient has passed successfully through three full term pregnancies.

TYPES OF LITHOPEDIONS

Kuechenmeister developed a hypothesis in an effort to explain the formation of calcified fetuses and classified the different types of this anomaly according to the degree and location of the process as follows:

1. *Lithokelyphos*. In this type calcification and fatty degeneration occur in the exudative lymph surrounding the fetal membranes and in the membranes themselves. As a result a stone like capsule is formed about the fetus, while the fetus itself may undergo slight or massive degenerative changes.

2. *Lithokelyphopedion*. This is a form in which the fetus becomes adherent to the sac, with both the fetus and sac showing widespread infiltration with lime salts. Kuechenmeister believed that this variety resulted when the amniotic fluid escaped or was absorbed, with the membranes themselves becoming tightly wrapped around the fetus.

3. *Lithopedion (stone child or lithocænon)*. This includes in general all types of calcified fetuses, although the term refers especially to the form in which the fetus itself undergoes organization and massive calcification. A true lithopedion forms when the fetus escapes unattached into the peritoneal cavity with or without the enveloping membranes.

Depending on the duration of the gestation outside of the uterus various changes inevitably take place in the fetal structures. Chemical alteration, such as saponification, and a drying process mummification frequently occur. After a time, lime salts are deposited in the fetal tissues or in the membranes, with the result that stone-like masses are finally produced. With these



Fig. 1. Roentgenogram of abdomen showing skeleton of fetus in the left side and lithopedion in the right side.

phenomena present, a fetus is designated a lithopedion.

It has been demonstrated that when mummification of an extra uterine fetus occurs, no trace of the placenta or placental tissue can be found. Mummification results from the absorption of fluids, whereupon the remaining soft parts are converted into hard parchment like material.

COMPOUND INTRA UTERINE AND EXTRA UTERINE PREGNANCY

The synchronous occurrence of an intra uterine pregnancy with an ectopic lithopedion is not often encountered. An advanced extra uterine gestation is usually discovered and surgically removed before lithopedion formation or calcification takes place. Occasionally an advanced gestation out side of the uterus becomes either mummified or calcified. Under such circumstances, the patient may become impregnated once or repeatedly and be delivered normally at term. During this time the old extra uterine pregnancy may escape detection. On the other hand, it may be discovered during the course of an intra uterine pregnancy. The designation of compound pregnancy describes this combination of affairs, namely, an intra uterine gestation associated with a long

TABLE I.—SUMMARY OF THIRTEEN CASES OF LITHOPEDION REPORTED IN THE LITERATURE

Author	Date of report	Features of case
Seeger	1915	Patient 37 years old. Rk carcinoma of breast, lithopedion behind uterus, probably of 14 years duration, having origin in failed abortion.
Kraus	1915	Lithopedion found at autopsy of 63 year old woman, who had had an extra-uterine pregnancy 40 years previously.
J. Davis	1915	Extra uterine pregnancy complicated by lithopedion, removed after operation when 23 years previously.
Altman	1917	Details not obtained.
J. Ralston	1919	Patient 3 years old had lithopedion for 8 years, during which time she had two normal pregnancies. Lithopedion discovered by X-ray examination during course of another pregnancy which terminated normally. Operation was refused.
B. Butler	1919	Patient, age 34, operated upon 3 years previous to present study for ruptured ectopic pregnancy. At that time the fetus was not recovered. X-ray examination revealed possible calcified fetus in upper right quadrant, and it was successfully removed.
J. Doe	1919	Patient, aged 35 years. Full term lithopedion retained for 3 years and successfully removed.
B. Walters	1921	Patient, age 34, carried mummified fetus for 7 years, during which period she gave birth to 3 full term children. Lithopedion was successfully removed.
G. Goetz	1921	Patient, age 34, passed through such labor and later had normal delivery. X-ray at admission showed extra uterine fetus with signs of calcification. No symptoms. Lithopedion weighing 10 pounds removed.
W. Engel	1921	Calcified lithopedion of 4 years duration in one tube with recent pregnancy in the other tube. Surgical removal.
Grimm	1921	Lithopedic mass of 16 years duration, diagnosed by the roentgen-ray removed surgically.
W. Zarn	1921	Lithopedion of 7 months development carried for 8 years, and removed successfully. One normal pregnancy in the interval.
J. Sato and Emmert	1923	Extra uterine full term fetus diagnosed by X-ray and studied roentgenoscopically throughout its course of lithopedion formation for 8 years.

standing mummified or calcified fetus in the abdominal cavity.

COMBINED INTRA UTERINE AND EXTRA UTERINE PREGNANCY

At this point it is of interest to mention that not infrequently an intra uterine gestation commences almost synchronously with an extra uterine one. The first case of combined intra uterine and extra-uterine pregnancy according to Novak, was recorded by Duverney in 1703, who discovered the condition at autopsy.



Fig. 2 Photograph of lithopedion. The mass weighed 2 pounds and 10 ounces and measured 15 centimeters in length, 10 centimeters in width and 7.5 centimeters in depth.

Neugebauer in two exhaustive contributions collected 244 cases of combined intra uterine and extra uterine gestation occurring in a period of more than 200 years (1708 to 1913). Novak found 32 additional cases of combined pregnancy of this type in the literature from 1913 to 1926. With the 2 cases which he personally observed the total reaches 278. In 1927 Bermann reported a pregnancy of 5½ months complicated by extra uterine gestation and dermoid cyst, which brings the total to 279 cases.

A CASE OF ADVANCED INTRA UTERINE PREGNANCY ASSOCIATED WITH ECTOPIC GESTATION OF LONG STANDING

Q. S., colored, age 25 years, registered at the prenatal clinic of the Jefferson Medical College Hospital on November 13, 1931. Her general health had always been good. She gave no history of previous operations. The menstrual epoch commenced at the age of 15; the cycle was of the 28 day type and was always normal. The last normal period occurred in the "middle" of May 1931.

The patient had had two full term normal pregnancies, and the children were recorded as being 11 and 13 years of age respectively. There was no history of missed periods or abortions. She felt well throughout the period of gestation and did not manifest symptoms of any kind.

Examination in the antenatal clinic revealed a fairly well developed colored woman exhibiting all the physical signs of pregnancy. The abdomen was enlarged to the size of a 7½ months gestation. In the right side of the abdomen, on a level with the umbilicus, a large mass, the size of a grapefruit, was felt. The tumor was not tender and on palpation it imparted a crackling sensation. The mass seemed to be external to the enlarged uterus and separate from it.



Fig. 3 Roentgenogram of lithopedion after its removal.

The patient was admitted to the maternity ward for radiologic examination and further study.

Laboratory findings. Wassermann and Kahn tests were negative. The blood count showed red blood cells, 3,750,000; white blood cells, 8,000; hemoglobin 70 per cent. Urinalysis was negative, except for 30 to 40 white blood cells, per low power field.

Roentgenological findings. Pycnography was included in the roentgen examination because of the presence of many leucocytes in the urine. Radiographic examination disclosed that the right renal pelvis and calyces filled normally with sodium iodide and that structurally the kidney was normal. The skeletal outlines of two fetuses could readily be made out. The fetus occupying the left side of the abdomen was viable, whereas the one on the right side showed overlapping of the cranial bones and apparently had been dead for some time. The head of the living fetus was directed toward the maternal pelvis, the back to the left of the maternal spine and anteriorly (L.O.A.). There was no evidence of disproportion between this fetus and the maternal pelvis. The fetus in the right half of the abdomen was encapsulated and much smaller than the viable one (Fig. 1).

The ureteral catheter was deviated slightly to the right in the pelvis, due to the presence of the fetal head. It passed up the ureter between the non-viable fetus and the viable one.

The plates of the skull of the non-viable fetus showed extreme overlapping, indicating that it probably had died at least several months previously. On palpation over the right half of the abdomen, there was an area of crepitation coinciding with the skull of the dead fetus. The crepitation seemed to be associated with the motion of the fetus on palpation.

The non-viable fetus was believed to be extra-uterine because the outline of the shadow of the uterus could be

seen, while that of the fetus fell to the right of it. There seemed to be considerable calcification of the membrane around the fetus.

From the radiographic findings the following diagnosis was made: Intra-uterine pregnancy (L.O.A.) extra-uterine pregnancy with dead fetus (Lithopedion).

Treatment. On December 3, 1931 a laparotomy was performed under general anesthesia. An encapsulated tumor about the size of a grapefruit (Fig. 2) which sprang from the right tube and was bound down to the cul-de-sac, was found. It was removed together with the tube and ovary. On the third day following the operation after a short, easy labor the patient delivered a stillborn, premature fetus spontaneously. Convalescence was entirely uneventful, the abdominal incision healing by primary union. Patient discharged in good condition December 23.

Description of lithopedion. The hard irregular mass (Fig. 3) weighing 3 pounds and 10 ounces, measures 5 centimeters in length, 6 centimeters in width, and 3 centimeters in depth. It is completely enveloped by a thick, gray, fibrous capsule to which a small ovary is attached. In several areas the skeletal structure can be distinctly palpated and the forms of the extremities are easily discernible through the sac. The hard, fibrous sac enclosing the fetus was probably formed from the amniotic membranes which had become infiltrated with lime salts.

A crackling sensation is imparted by the mass to the fingers and especially by the bony plates of the skull. When the indurated capsule was incised, decomposing bones and tissue protruded. Several small bones had undergone such decomposition that they dropped out when the capsule was incised.

From the appearance of the bones, it would appear that the fetus had reached 7 or 8 months' development before death had taken place. As the specimen was not dissected, it is impossible to state the character of preservation of the innermost contents.

Figure 3 is roentgenogram of lithopedion after removal.

The case of lithopedion described herewith illustrates the importance of careful routine antenatal examination. Only by such procedure is it possible to minimize the danger of inadvertently overlooking abnormal conditions which ordinarily do not give rise to special subjective symptoms.

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ELECTROCOAGULATION OF THE MELANOMA AND ITS DANGERS

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A SERIES of 27 cases of melanoblastoma of the skin was reported a short time ago¹ at which time one was disappointingly impressed with the failure of our existing methods of treatment. The treatment of these melanotic growths by the popular use of the electric needle² disclosed several facts which led to this study. In the series studied those cases treated by electrocoagulation showed a 100 per cent recurrence at the site of the primary with early regional and generalized metastasis in the majority of cases. The untreated melanoblastoma progressed less rapidly to local and general metastasis than those electrocoagulated. The average time for the appearance of regional metastasis in the cases so treated was 5½ months and 11½ months for generalized metastasis.

The term melanoma which specifies the character of the tumor cell containing a variable amount of an iron free pigment, melanin will be used in an endeavor to show no partiality as to the connective tissue epithelial or endothelial origin of these growths.

The malignant melanoma has its origin as a rule from the nevus cells of pigmented warts and moles. The benign melanoma or pigmented nevus consists essentially of a localized area of pigmented basal cells with the presence of so called 'nevus' cells arranged in groups or columns in the upper corium.

In the study of this problem the following observations were made permitting of possible explanation of the facts and presenting an application to the entire field of electrosurgery of malignancy.

A more complete understanding of the changes taking place may be possible if a review of the mode of metastasis of the malignant melanoblastoma is made. The lymphatics of the skin are collected from very fine capillaries in the epidermis in lymphatic trunks in the fascial planes, which eventually terminate in the regional lymph nodes. It has been shown by Campbell de Morgan and later by Handley that the growth of melanoblastoma occurs first along the lymphatics. Figure 1 demonstrates the mechanical permeation of the lymphatics in the corium *E*, and in the fascial plexus *C* the spread of the tumor cells occurring along the line of least resistance. Handley, after extensive investigation has described

three zones surrounding the primary lesion. Farthest from the lesion in the fascial lymphatic plexus only (Zone I) with no invasion of the surrounding tissues are found the tumor cells entirely within the walls of the lymphatic vessels *C*. Within this zone is an area of inflammatory reaction (Zone II) with perilymphatic leucocytosis and fibrosis due to rupture of distended lymphatics of the fascial plexus with melanotic tumor cells with a retrograde permeation of the subepithelial tributary lymphatics toward the skin, *E* and invasion of the fascia and muscles. Nearest the primary growth is a zone (Zone III) in which all of the permeated lymphatics have become strangulated by the perilymphatic fibrosis incident to the inflammatory reaction set up by the presence of the tumor cell and, as a result, the lymphatics have entirely disappeared thus leaving only isolated large nodules of malignant cells (*H J*) increasing in size and invading the neighboring vessels, both veins and arteries. That blood vessel dissemination occurs secondarily to lymphatic permeation is thus clearly shown. It is seen that the process is entirely mechanical the tumor cells spreading most widely in the larger, deeper lymphatics and invading the corium and epidermis only after the inflammatory process set up by their presence has been sufficient to fibrose and choke the deeper lymphatics.

A group of benign skin lesions was carefully selected in studying the changes taking place in the skin and subcutaneous tissues on electrocoagulation in the hope that while dealing with a benign lesion sufficient changes might be safely observed and application made to the malignant lesions.

A group of senile keratotic lesions were treated with the electric desiccating needle. In this series so treated many of the lesions were surrounded by dilated venules which extended from the lesion for several centimeters in normal tissue. It was in this particular group that the observations were made. Definite changes, visible to the naked eye took place. On application of the desiccating or coagulating needle to the central portion of the lesion, globules and bubbles appeared in the deeper portions and at the periphery. As the process proceeded a venule at the periphery would suddenly dilate to twice its normal size and blanch free from blood, beginning at the proximal end nearest the lesion and extending to its most



Fig. 4. Epidermis with primary melanoma *G H* corium with blood vessels *F* and superficial lymphatics *E*, *C* fascial lymphatic trunk *D* muscle. Zone I is furthest from the primary lesion, the melanotic cells are entirely within fascial plexus *C*. Zone II—fewer melanotic cells are present within fascial plexus perilymphatic leukocytosis *I* and fibrosis of lymphatics, permeation of superficial lymphatics *E* toward epidermis in corium and in muscle. Zone III is nearest the primary lesion. There is complete fibrosis of the fascial lymphatic plexus invasion of vessels *J* with melanotic cells groups of melanotic nodules *II* free in corium and muscle.

W. H. H. H.



Fig. 5. Senile keratotic skin lesion with surrounding visible dilated venules.

distal part. This same phenomenon could be made to occur in each of the peripheral visible venules by continuing the coagulation. In several instances the escaping globules of tissue steam or gas would suddenly fill the venule and express the blood to its distal end only to dilate the vessel to still greater size as the coagulation continued. Figures 2 and 3 illustrate the appearance of the lesion and dilated venules surrounding both before and following electrocoagulation. Thus was demonstrated the mechanical passage of tissue gases, generated by electrocoagulation, into the visible venules surrounding the lesion.

That such a phenomenon occurs not only in the visible venules but also in the deeper vessels and lymphatics can hardly be denied. The application of this observation to the use of the electric needle in the treatment not only of malignant melanoma but to malignancy in general thus becomes appalling.

With the peculiar lymphatic metastasis here before described and so ably demonstrated by Handley, the mechanical passage of the tumor cells along the line of least lymphatic resistance and secondarily by direct extension into the blood stream the result of electrocoagulation can be readily appreciated. The tissue gas bubbles generated during the process, which are forced under apparent pressure into the surrounding lymphatics and vessels, carry before them the unstable malignant cells which without this assistance are already passing widely along the lymphatics and thus force the invasion to even greater dimensions.

In referring to Figure 1 in which the three zones surrounding the skin lesion are demonstrated it is seen that the malignant cells are farthest removed from the primary lesion in the fascial lymphatic trunk *C*. Actually to state the actual dimensions of Zones I, II, and III and with any

degree of certainty determine the definite extent of progress in the fascial plexus of Zone I is impossible because of the varying grades of malignancy, duration, and treatment.

In reviewing the cases treated by electrocoagulation, one is confronted with a large number in which the skin lesion itself has been attacked. In another group the electric needle has first been passed through apparently healthy tissue at varying distances from the primary lesion completely encircling the lesion before its actual coagulation. The explanation of the second procedure being to seal off the lymphatics before attacking the primary. In both groups the recurrence was 100 per cent.

An explanation of the same degree of recurrence in the group in which the lesion is first completely encircled through apparently healthy tissue is now possible of explanation. Although the process has been carried through apparently healthy tissue on the basis of being wide of visible superficial lesion the malignant cells are present in the fascial plexus at greater distances, even in many instances to the nearest group of lymph nodes. While the lesion is being surrounded by the needle the tissue gas is generated in exactly the same manner as in coagulating the primary lesion and when the fascial plexus is encountered the bubbles escape into that avenue and force before them the malignant cells present to an even wider extent.

Reference to Figure 4 again illustrates the three zones surrounding the primary growth. Figure 4 illustrates diagrammatically what occurs by the generated tissue gas in forcing the malignant cells wider when the lesion is encircled through apparently healthy tissue.

Thus far the discussion has dealt only with the treatment by electrocoagulation of those mel-

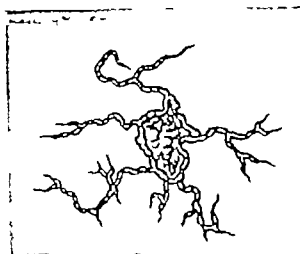


Fig. 3. Senile keratotic lesion seen in Figure 2 following electrocoagulation, demonstrating the dilatation of the venules by tissue steam.

anoma which are known to be malignant. That a sufficiently large group of benign melanoma of the skin exist which show malignant change following treatment with the electric needle is not denied although the difficulties arising in determining the actual percentage is wellnigh impossible. Of the 27 cases in this series, the mole was present in 21. In a previous paper the writer endeavored to show that moles birthmarks and warts of congenital origin may remain benign and unnoticed for years only to undergo malignant changes later thus presupposing an exciting factor. Undoubtedly this factor in the majority of cases arises as chronic irritation. Some writers regard the melanin pigment in the light of a chemical irritant which may first produce an abnormal epidermal cell proliferation. Borst and others hold that it is set free in the tissue spaces and initiates a malignant proliferation in the endothelial and connective tissue cells. That the presence of a congenital nevus or birth mark is not essential in the production of a malignant melanoma is evidenced by the reported cases of the development of malignant melanoma arising in the puncture wounds, e.g. from a thorn in the foot, especially in the races of the upper Nile. The writer reported a case of malignant melanoma arising in the puncture wound on the leg of a paper hanger as a result of pricking the leg with the points of his scissors carried at the side. Handley explains this as being due to the traumatic implantation into the subcutaneous tissue of a group of dermal connective tissue cells of actual or potential chromatophores.

It seems reasonable to conclude that the improper coagulation of benign skin lesions with the electric needle acts not only as an acute irritant

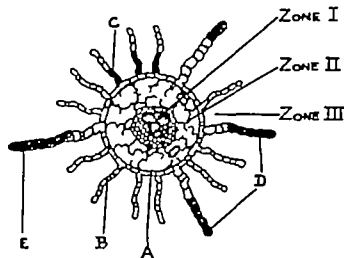


Fig. 4. 1. Site of electrocoagulation by encircling primary growth. B subfascial lymphatics containing tumor cells. C fascial lymphatic containing tumor cells in Zone II. D fascial lymphatics dilated with tissue gas from electrocoagulation. E, tumor cells forced beyond Zone II by pressure of tissue gas in fascial lymphatics.

in stimulating cells to malignant change but also sets free the abundant melanin present in the tissue spaces where it acts as a chemical irritant according to Borst and traumatically implants into the subcutaneous tissue the actual chromatophores according to Handley thus causing malignant change.

Until some future time when a better method of treatment for this most malignant of diseases is advanced surgical excision with due respect to the anatomical disposition of the lymphatics and thorough knowledge of the spread of the neoplastic cells should remain the procedure of choice. A wide circular or elliptical incision should be made through healthy tissue far removed from the primary growth. The surrounding skin should be elevated or undercut as far as possible and the subcutaneous fat and fascia incised at the extreme base of the undercut skin in a circular manner down to the underlying muscle. The entire mass of primary growth subcutaneous fat and fascia, with a thin portion of underlying muscle is then removed by a sharp dissection. Greater assurance is then obtained by removing the gland draining area in the same as described fashion.

SUMMARY

1. The cases of malignant melanoma in a series of 27 cases treated with the electric needle showed a 100 per cent recurrence.

2. Electrocoagulation of a group of senile keratotic lesions demonstrated the escape of tissue gas into the peripheral visible venules under pressure.

3. An application of this discovery to electrocoagulation of malignant melanoma renders plausible the explanation of high recurrence on the basis of the mechanical forcing of unstable malignant cells more widely into the tissues by pressure exerted in the lymphatics and vessels by generated "tissue gas."

4. Preliminary encircling of the primary growth with the electric needle through apparently healthy tissue is unsound as the fascial lymphatics wide of the primary lesion may be filled with tumor cells the same phenomenon of generated "tissue gas" pressure occurring here with similar results.

5. Inefficient treatment of benign skin lesions, especially the benign melanoma with the electric needle may initiate malignant change by acting

as an irritant or by the implantation of potential chromatophores into the subcutaneous tissue.

6. Surgical excision of these lesions with special reference to the anatomy and mode of metastasis, remains the procedure of choice.

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A CONTINUOUS FIGURE-OF-EIGHT SUTURE FOR MUSCULAR AND PERITONEAL APPROXIMATION IN CÆSAREAN SECTION

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WHEN closing the uterine wound in cesarean section practically all operators use first a continuous stitch which unites the innermost fibers of the muscularis and avoids the mucosa. This suture line is shown in Figure 1. The closure of the remainder of the uterine wall so as to secure accurate coaptation and hemostasis without constriction of tissue has always been a problem. The difficulty is increased when the uterine wall is unusually thick. I have in the past employed for this purpose one or more layers of interrupted single, or of continuous or single figure-of-eight sutures according to the nature of the case. It has been found however that none of these methods was ideal or that none would produce even approximately the desired effect in every case. To overcome these objections I have of late been using a continuous figure-of-eight suture which seems to solve the difficulty in a satisfactory manner. It unites at the same time the middle portion of the muscularis and the superficial muscle fibers along with the serosa and secures good approximation and hemostasis. Because of the length of the suture, which makes for elasticity and the absence of knots except at the two ends there is no constriction of tissue.

While designed primarily for the classical cesarean section it may be used equally well in closing a vertical incision in the lower segment. In the latter case one begins at the lower angle of the wound where the uterine wall is thin with an over and over stitch which is continued upward until the thicker portion is reached when the figure-of-eight is begun.

Three-quarters of a length of chromic catgut is threaded on a round pointed curved needle but is not tied in or rethreaded. Beginning at one angle of the wound the suture is passed through the intermediate zone of the muscularis on either side and tied thus anchoring the stitch. The needle is then reversed in the needle holder and passed from within the wound outward on one side through the superficial muscularis and peritoneum. Still keeping the needle reversed the suture is passed through the peritoneum and superficial muscularis of the opposite side into the wound. As the stitch is tightened, it closes the peritoneum and buries the first knot. The needle is then placed in the usual position in the needle holder. Bites are taken in the deeper portions of the muscularis as before the needle is again reversed and the outer portion of the wound united.

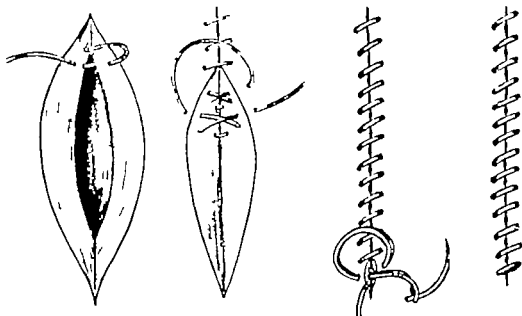


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1. Sutureline. Fig. 2. Detail of suture.
Fig. 3. Taking last superficial stitch.

Fig. 4. The suture has been cut, the end dropped into the wound, and final knot buried.

as described (Fig. 2). These maneuvers are continued until the last deep stitch has been taken and the final superficial loop is about to be placed. At this point as the needle is passed from within outward the assistant grasps the free end of cat gut and draws it taut. The needle is then passed from without inward, making the last superficial stitch one of double suture material (Fig. 3). The

suture is now tied and cut and its end falls into the wound leaving the final knot also buried (Fig. 4).

Although I have seen no reference to this method of suture it is possible that it has been used and described before. Should that be the case I would gladly surrender priority to anyone who wishes to claim it.

BRANCHIAL AND THYROGLOSSAL DUCT CYSTS AND FISTULAS IN CHILDREN

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THE clinical picture of branchial and thyroglossal duct cysts and fistulas is frequently unrecognized. Particularly is this true in children when the cysts and fistulas are so often mistaken for abscesses or broken-down lymph glands, and are repeatedly incised and drained without effecting a cure. Although many are not manifest until later years, probably the greater majority of branchial and thyroglossal duct fistulas and cysts that do occur in children are not properly treated until adult life.

EMBRYOLOGY

Noteworthy studies of the embryology of the branchial apparatus have been made by Rathke, His, Born, and others. Undoubtedly the greatest single contribution is that of Wenglowski who in 1912 published a monograph in which he gave the findings of detailed study of serial sections of a large number of human embryos beginning with 2 millimeters and ending with 49 millimeters. I shall first briefly outline the embryology according to Wenglowski and then deal with the clinical side of the subjects.

During the second week of embryonic life certain changes take place in the fetal foregut (Fig. 1). From the interior lateral walls of entoderm five outpouchings or diverticula appear. These are called pharyngeal pouches. Simultaneously the external ectoderm becomes indented over the corresponding pharyngeal pouches. These are the branchial or outer pharyngeal grooves. As the small grooves approach the pouches, the mesoderm is pushed aside so that for a time ectoderm and entoderm come into contact. The contacting areas are the closing membranes which in gill-bearing animals disappear forming the gill clefts,

opening from the pharynx to the exterior. Such perforation of course does not normally occur in birds and mammals.

The grooves and pouches thus formed, separate a series of rounded bars of mesoderm which has been pushed aside by them. These are termed branchial or visceral arches, of which there are 6 all meeting ventrally in the midline of the neck. In each arch there is developed a cartilaginous bar consisting of a right and left half and in each bar also is the anlage of one of the primitive aortic arches.

The first arch is called the mandibular arch, and from it are developed the lower lip, the mandible, the muscles of mastication and the anterior part of the tongue. Its cartilaginous bar forms the focus, malleus, and a portion of the mandible.

The second is the hyoid arch. It gives origin to the structures of the upper part of the neck. From its cartilage are developed the styloid process, stylohyoid ligament, and lesser cornu of the hyoid bone. The first two arches grow more rapidly than the remainder so that the latter four become telescoped the first two arches leaving a deep depression, the cervical sinus. (Wenglowski claims that the third arch telescopes to form the sinus.) The ventral ends of the second along with those of the third arch, assist in formation of the body of the hyoid bone and the posterior part of the tongue. The third arch assists in the formation of the sides of the neck and its cartilage gives origin to the greater cornu of the hyoid. The fourth and fifth arches also assist in forming the sides of the neck, while the ventral portions of their cartilages unite to form the thyroid cartilage. The sixth arch gives origin to the cricoid, arytenoid, and tracheal cartilage.

From the first external indentation, the first branchial groove arise portions of the auricle and external acoustic meatus while of the second third and fourth grooves no traces persist

From the first internal outpouching first branchial pouch, are formed the auditory tube and tympanic cavity the tympanic membrane arising directly from the closing membrane between the first and second arch. In the second pouch lies the anlage of the tonsil Wengowski demonstrated that from the third pouch on either side a small duct the thymic duct, descends into the mediastinum to form the thymus. This duct passes in the general direction of the sternomastoid muscle laterally to the thyroid and is lined with squamous epithelium surrounded by lymphocytes. He likewise demonstrated remnants of this tubule in adult necropsy dissections. From the fourth pouch a comparatively short tubule passes on either side in a somewhat medial direction to form the lateral lobes of the thyroid. The parathyroids likewise originate in this pouch. The fifth pouch gives origin to the ultimobranchial bodies which although enveloped by thyroid tissue leave no identity in the human adult.

During the third week a rounded swelling or bud appears on the ventral side of the foregut just behind the first arch. This is the tuberculum impar which along with two similar swellings appearing laterally form the anlage of the buccal part of the tongue. A V shaped swelling arising somewhat posteriorly is called the copula and is the anlage of the posterior part of the tongue. In the fourth week a diverticulum descends between the tuberculum impar and copula and passes as a tubular duct downward anteriorly to the trachea to form the middle lobe of the thyroid gland. The point of descent remains as a depression at the base of the adult tongue which is known as the foramen caecum. The tubular structure is the thyroglossal duct. It later atrophies and is obliterated but occasionally remains patent, producing the congenital anomaly thyroglossal duct cyst or fistula.

BRANCHIAL CYSTS AND FISTULAS

There are several theories regarding the evolution of branchial cysts and fistulas. (1) That they are caused by a vestigial remains of the branchial grooves or pouches. (2) That they are a result of an embryonic perforation of the closing membranes. (3) That they are a persistence of the cervical sinus formed by the telescoping of the rapidly growing first and second arches over the remaining arches. (4) That they are due to a remains of the thymic duct which descends from

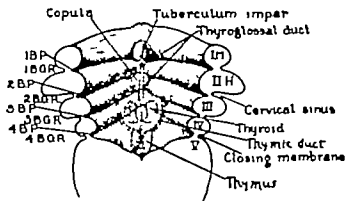


Fig. 1. Schematic drawing showing development of branchial apparatus. I M Mandibular arch. II H, Hyoid arch. III IV Third fourth and fifth branchial arches. 1 B P 2 B P 3 B P 4 B P First second third and fourth branchial pouches. 1 B G R 2 B G R 3 B G R 4 B G R First, second third and fourth branchial grooves.

the third pharyngeal pouch as demonstrated by Wengowski in 1912

Clinical features A distinction is frequently made between branchial cysts and fistulas and each spoken of as a distinct entity. It appears however that they are all simply a sinus tract which forms a cyst when the drainage is inadequate or obliterated. The lining of both cysts and fistulas consists of squamous epithelium surrounded by a cover of lymphoid tissue.

According to E. Wyllys Andrews, there are five types of branchial cysts or fistulas: (1) complete branchial fistula with internal and external opening (2) incomplete external fistula no internal opening (3) incomplete internal fistula no external opening (4) branchial cysts no internal or external opening (5) branchial dermoid.

The surgical records of the Childrens Hospital show only 4 cases of branchial cysts and fistulas. This is however not a true index of the incidence of this anomaly. In 1929 Hyndman and Light reviewed a series of 90 cysts and fistulas. In their series the average age of onset was 17 years and the condition was noticed at birth in only 21 per cent, and only 11 occurred before the age of 11 years which is the age limit of admission at the Childrens Hospital. The ages of these 4 children were 2, 2, 3 and 9 years, respectively. There were 2 each girls and boys. The sides of the neck involved were likewise equally represented. The age of onset of these children was, at birth at 2 months at 18 months and at 7 years. In the cases reviewed by Hyndman and Light, 53 occurred in females and 47 in males and of the 28 cysts 35.5 per cent were on the right side and 64.5 per cent on the left, while of the 62 fistulas, 51.8 per cent were on the right, 31.4 per cent on



Fig. 2. left. Branchial cyst which developed after infection of fistulous tract

Fig. 3. Branchial fistula, showing small opening on the left side at about the middle third of the sternomastoid.

the left, and 16.8 per cent were bilateral. Multiple openings occurring on 1 side are indeed, rare. There is but one reported by Virchow in 1861. Familial tendency is likewise not the rule, but again scattered cases have been reported. In Virchow's report of 1861 there is the occurrence in a mother and 8 children, and 2 other cases of family tendency, and in the 1929 study of Hyndman and Light they reported cases in which the mother and 3 of her 5 children presented fistulas.

Clinically a branchial cyst usually manifests itself simply as a uniform painless, nontranslucent semispherical fluctuant tumor which is never tender except from pressure or secondary infection (Fig. 2). Ordinarily its presence does not cause the child any particular discomfort. There have, however, been reports of serious trouble caused by pressure on neighboring structures, particularly difficulty in breathing or swallowing. Thomson of England reported a branchial cyst which produced hoarseness and was accompanied by a fixed vocal cord. When the swelling was at its height, there was dysphagia and cough with complete misery of his patient. At exploration, the cyst was found attached to the larynx and passed to the lateral wall of the pharynx. The symptoms completely subsided after excision of the cyst. A branchial cyst has a uniformly characteristic position along the anterior border of the sternomastoid and extends under it to the deeper structures of the neck. The size depends upon the amount of drainage or secretion present and may vary from a centimeter in diameter to almost fill

ing the entire side of the neck. The average size, however, is about that of a walnut.

The clinical picture of branchial fistula is that of a sinus which periodically drains a mucoid or thin milky material which may be associated with a cyst, depending upon adequacy of drainage. The fistula is also not prone to give any serious trouble in the average case except that the discharge is annoying to both parent and patient and the fistulous tract often stops drainage for a time with the production of a cyst which again periodically empties itself.

Not infrequently however repeated secondary infections do take place with an occasional serious cellulitis of the neck. Also some very aggravating conditions have been observed. A case reported by Louis Carp in 1926 is that of a boy 5 years of age who, with a branchial fistula gave a history of an unproductive cough of 2 years duration which was unsuccessfully treated by tonsillectomy and medical measures. At exploration an incomplete fistulous tract was found adherent to the vagus nerve. Excision of the tract brought about relief of all symptoms which were as the author stated quite surely due to vagal irritation. It is known that probing or pinching a tract has produced vagal symptoms such as cough, palpitation, intermittent pulse, hoarseness, pallor and sweating. I have had occasion to operate on an 18 months old child whose mother said the baby had had asthmatic attacks whenever the fistulous tract stopped draining and became distended. This appeared to be undoubtedly a case similar to that reported by Carp. Furthermore, at operation

a distinct nerve fiber was found attached to the tract extending deep to the carotid sheath apparently leading to the vagus nerve. The child has however had several mild attacks since and has been found sensitive to milk.

The fistulous opening may be situated at any level of the neck but is constantly and without variation just anterior to the sternomastoid muscle (Fig. 3). There is sometimes an area of pigmentation about the opening and occasionally a thickened bit of tissue may be felt which contains a bit of cartilage and is called the cervical auricle. The fistulous tract almost invariably runs upward and backward beneath the anterior portion of the sternomastoid muscle. It passes over the carotid sheath to the midportion of the posterior belly of the digastric muscle whence it arches medially behind the stylopharyngeus muscle to the tonsillar fossa. By tugging at the skin over the opening one can often feel the cord like structure extend under the sternomastoid.

Bearing in mind the close relationship that exists between the anatomy and histology of branchial fistulas and the embryology of the thymic duct one must readily agree with Wenglowski that the origin of this condition must be attributed to vestigial remains of the thymic duct. Contradicting this theory some authors argue that one occasionally sees a fistulous opening in the region of the ear which is above the level of the third pouch. These are probably either secondary to infection or in most cases are rudimentary external ear canals from the first groove.

With the typical clinical picture a diagnosis is usually comparatively easy. As a further aid in diagnosis, Hamilton Bailey in 1922 demonstrated the presence of cholesterol crystals on microscopic examination of aspirated content in some cases. Wangenstein gives a further aid to differential diagnosis by X ray examination suggesting aspiration through a needle and injection of a medium opaque to the X ray (Fig. 4).

Differential diagnosis must be made from inflammatory and tuberculous adenitis, hygroma, thyroglossal duct, hemangioma, and lipoma.

Inflammatory adenitis is often bilateral and numerous glands are involved. They are tender and the offending focus usually can be found in sore throats, tonsils and teeth. Tuberculous glands may be more readily confused with cyst and fistula but they are firm and tender and other glands usually are involved and often matted together in a group. The discharge from the fistula in broken down glands is purulent while in branchial fistula it is clear mucoid or milky and may contain cholesterol crystals.



Fig. 4. Branchial fistula, lipiodol injection showing characteristic extension beneath sternomastoid to middle portion of the posterior belly of the digastric muscle where it arches medially to the tonsillar fossa.

Cystic hygroma is translucent, occurs most frequently in the supraclavicular area, is often lobulated and may grow to enormous proportions extending up into the face in front of the ear.

The thyroglossal duct occurs invariably in the midline and moves up on swallowing.

Hemangioma decrease in size on pressure and have the typical discoloration.

Lipomata are lobulated, soft, and non fluctuatory.

TREATMENT

Frequent incision and drainage is often the lot of these children before the condition is recognized and properly treated. Two of our 4 children had incision and drainage without benefit before entering hospital. Only complete surgical removal under general anesthesia will effect a cure.

The extent of the sinus tract should be roughly determined before operation by injection of an opaque medium and X ray (Fig. 4). Visualization of the tract may be facilitated by a simple method described by R. J. McNeill Love. A horse hair or dermal pursestring suture is placed about the fistulous opening and drawn taut to shut off secretion. In a few days the tract becomes distended and identification is then comparatively easy.

The injection of methyl blue as ordinarily carried out, is usually a messy job. As the tract is



Fig. 5. Excision of branchial fistula showing armamentarium and method of massaging methyl blue into the tract.

opened somewhere in the course of dissection, the dye spills, stains all the surrounding tissue and all identification is lost. I have however found methyl blue to be a distinct aid when used in the following manner (Fig. 5).

The end of an ordinary hypodermic needle is broken and rounded off the caliber of the needle depending upon the size of the fistulous opening. The direction of the tract is determined with a probe and the methyl blue then injected with the use of the blunted needle. Too great a pressure may rupture the tract and defeat the purpose of the injection. At the same time the fingers of the left hand gently massage the neck to and fro in the direction of the tract. Thus the epithelium in even the minutest diameter of the tubule may be reached and stained. Using the same syringe and needle we then gently but thoroughly wash out the methyl blue with water or saline alternately massaging outwardly until the return is only



Fig. 6. Incision of branchial fistula, showing assistant's finger pushing outward in the region of the tonsillar fossa, as dissection is carried to the pharynx.

faintly stained. In this manner the epithelial lining remains stained and if the tract is longitudinally opened during the dissection no soiling of the neighboring structures will take place.

A small probe is again inserted and the incision made through skin and platysma along the anterior border of the sternomastoid and surrounding the fistulous opening. The platysma is reflected laterally on both sides, and the sinus is dissected to the pharynx in its entirety. The stump may be dealt with by several methods as recently described by Herbert Willy Meyer. By the method of von Hackerer a probe is passed through the lumen of the duct into the pharynx, and with a suture the stump is attached to the probe and inverted into the mouth cavity and there tied and cut. By the method of Koenig a probe is forced into the pharynx a short distance from the duct which is then sutured and pulled with the probe into the pharynx, thus re-implanting it. The method of von Hackerer appears most desirable for several reasons: there is not the possibility of hemorrhage from passage of the probe; there is not the danger of opening of fresh avenue of infection from the mouth and chlorea; it does away with the entire tract. Minute tubules would however be rather difficult to invert.

I have found that dissection of the stump may be carried to the pharynx by simply having an assistant place a finger in the tonsillar fossa

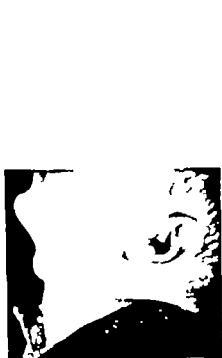


Fig 7. left. Thyroglossal cyst occurring at the level of the hyoid bone.

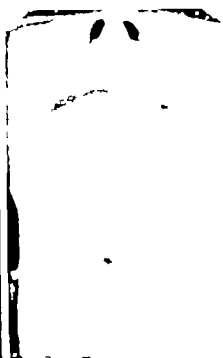


Fig 8. Thyroglossal duct fistula, showing characteristic midline opening.

(Fig 6) By having him push outward the stump is cored out until it approaches the finger of the assistant when it is severed and touched with tincture of iodine. A small split tube is inserted for drainage for 24 hours and closure made in the usual manner.

THYROGLOSSAL DUCT

The development of thyroglossal duct cysts and fistulas is definitely established as being the result of a failure of the embryonic thyroglossal duct to become obliterated.

Clinical features The condition is more common than branchial cysts and fistulas. At the Childrens Hospital there were 11 children who came to surgery for thyroglossal duct excision. Of these 6 were boys and 5 were girls. One was a negro boy 2 were Mexican 1 Italian and the others of American families. The ages ranged from 2 to 11 years of age. In 1925 Klingenstein and Colp received 42 cases of thyroglossal ducts and in their series 31 were males and 11 females. Twenty-one occurred in the first decade 10 in the second 7 in the third and so on. The oldest age at which the lesion was discovered was 35 years the youngest, of course at birth of which these were 5. In the Childrens Hospital series the onset at birth occurred in two instances. In the remainder the age of onset was at 6 months 18 months, 2, 3, 3, 6, 8, 9 and 11 years, respectively. Adequacy of drainage decides whether a cyst or

fistula is formed. In the series of Colp and Klingenstein there were 13 cysts 20 fistulas and a combination in 9 cases. In this series 3 were simple cysts only 1 a simple sinus and the remainder were fistulas which were associated with cystic formation.

The cyst may appear at any level from the foramen cecum to the suprasternal notch and the corresponding fistula may make its exit anywhere from the chin at the floor of the mouth to the suprasternal notch. It is rarely however that it appears above the hyoid. The majority of fistulas open below the hyoid and considerably higher than the suprasternal notch. All are invariably in the midline and may vary in size from a pea to a lemon (Fig 7).

The clinical picture of the cyst is that of a painless, soft fluctuatory semifixed mass occurring in the midline of the neck and moving up on swallowing. With a fistulous opening there is either a continuous or intermittent drainage of a clear or milky solution (Fig 8). Troublesome symptoms such as a choking sensation difficulty in swallowing and obstructive dyspnoea are rare but secondary infection either ascending from the external opening or descending from the foramen cecum is fairly common. With infection the process usually remains localized and discharges through the sinus opening although occasionally a severe cellulitis of the neck develops. All too frequently the simple non infected cyst is mistaken

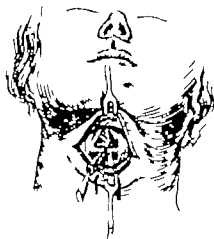


Fig. 9. Excision of thyroglossal duct fistula. The platysma muscle has been reflected and dissection carried to the hyoid bone.

for an abscess, and consequently a history of repeated incision and drainage without cure is obtained. Two of our children had thus been treated in one of which a later attempt at removal had been undertaken and in a other children removal had been previously attempted but the operation had been without success in affecting a cure.

The sinus tract may pass over through or beneath the hyoid to the base of the tongue. The larger tract may be felt as a distinct tubule lying over the trachea and moving on swallowing. The

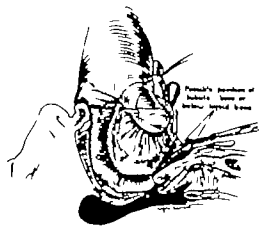


Fig. 11. Excision of thyroglossal duct fistula. The mid-portion of the hyoid bone has been removed. From this point the tract is carried out in the direction of the foramen cecum, which is at about a 45 degree angle with the patient in the goiter position. Dissection is carried up to a point where the finger at the foramen cecum can be identified (Sistrunk).

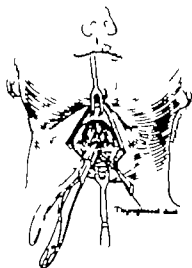


Fig. 10. Excision of thyroglossal duct fistula. The mid-portion of the hyoid bone is being removed with bone forceps according to the method of Sistrunk.

lining consists of squamous epithelium surrounded by lymphoid tissue.

Differential diagnosis must be made from ranula adenitis, pyramidal lobe of the thyroid, and the branchial cleft anomalies.

Ranula of the sublingual gland occurs in the anterior part of the floor of the mouth and can be seen as a bluish cyst under the floor at the anterior part of the tongue and does not move on swallowing.

Adenitis, either single or tuberculous, occurring in the midline of the neck, is rare indeed and is associated with other tender glands. Movement on swallowing does not take place.

A pyramidal lobe is attached to the thyroid near the isthmus. It is practically never enlarged unless it is associated with a goiter and it does not fluctuate.

TREATMENT

As in branchial cysts and fistulas, complete excision under general anesthesia is the only cure. The fistulous tract should be stained according to the method described in treatment of branchial tracts.

W. E. Sistrunk has described a highly satisfactory method of removal and his is the technique I shall here describe.

A horizontal incision about 1 1/4 inches long is made through skin and platysma and surrounding the sinus opening. The flaps are reflected and the dissection of the tract carried to the hyoid bone (Fig. 9). The sinus may pass over through

or beneath the hyoid bone to the foramen cæcum at the base of the tongue. Beyond the hyoid the tract frequently assumes minute proportions. To facilitate further removal a section of the mid portion of the hyoid is removed with bone cutting forceps (Fig. 10). An imaginary line is pictured from the hyoid to the middle of the base of the tongue. This is about at a 45 degree angle with the patient in a goiter position on the operating table. Dissection is carried further in the exact direction of the foramen cæcum. To orient himself and to aid the dissection the surgeon places a second sterile glove and sleeve over the left hand. The index finger is placed in the mouth of the patient at the foramen cæcum and pushed out toward the hyoid bone. At the same time the fistulous tract is cored out to the base of the tongue (Fig. 11). A split tube drain is inserted. The cut ends of the hyoid approximated. The platysma is then sutured with interrupted plain No. 00 catgut and the skin closed in the usual manner.

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REACTIONS AFTER INTRAVENOUS INFUSIONS

A FURTHER REPORT ON THEIR ELIMINATION¹

IEF RADJIAKFR, M.D. PHILADELPHIA

IN a previous report, the causative factors of reactions after intravenous infusions and the theoretical elimination of these reactions were discussed. Since that time Perkins has summarized the more recent literature and has discussed the subject in a very thorough way. It is the purpose of this contribution to discuss our practical experience in applying the principles developed in our previous report.

When beginning a study of intravenous solutions, an evident lack of organization and method of preparing solutions was evident in our hospital. Solutions were prepared in individual dressing rooms from bottles of commercial distilled water many of which had been standing unused for months. Glassware was merely rinsed, and a commercial and impure glucose was used in the preparation of the solutions. The majority of glucose used came from ampuls of 50 per cent glucose from various manufacturers, being diluted with saline solution prepared in the hospital. Solutions of uncertain age were used oftentimes a month old due to the fact that flasks were labeled only on the initiative of the individual dressing room nurse. Needles were often rusty—tubing was prepared by boiling in a water sterilizer containing from 10 to 40 grains of bicarbonate in 3 gallons of water. From the standpoint of our later experiences it seems queer that an infusion could ever have been given under these circumstances without an accompanying reaction. Later a Barnstead single still was used, the water being distributed in bottles and again kept in dressing rooms for various intervals. This naturally gave no improvement.

When our new distillation apparatus was installed the first measure applied to correct all these evils was to install a central supply room all solutions being prepared by one individual and delivered to wards and floors as requested. Later we found that even the shifting personnel of student nurses would not suffice because of interference with the work by other duties, and a graduate nurse was put in charge of all solutions. It is also advisable where possible to have all equipment for the administration of intravenous fluids taken care of in one central supply room, but this change we have not been able to effect here.

To apply the theories developed in our earlier work we applied first to the Barnstead Still and Sterilizer Company to design for us a suitable distillation apparatus. The still designed by them is of the continuous distillation type with horizontal condenser. Multiple baffle plates were placed in the upper portion of the still and a smaller set in the vertical portion of 3 inch pipe to the condenser. This system forces the steam to turn many angles, striking against numerous plates, thus losing its spray. In addition to this a deconcentrator tube as described by Severinghaus was attached. This consists of a $\frac{1}{4}$ inch brass pipe introduced through the bottom of the still and attached to the waste pipe by a valve and with an air vent. The tube rises vertically in the center of the reservoir about one third of its height. The level of water is kept about one-half inch above the open end of the tube. When the valve is open the surface of the water is constantly in motion toward its center which greatly diminishes the formation of spray. Increased concentration at the surface which is another cause of spray formation, is also prevented by this tube. Other satisfactory distilling sets were on the market, especially the double and triple distillation outfits with baffle systems, and although these might be slightly more satisfactory they were more expensive and did not promise to be much more effective in removing pyrogenic material. In the use of this apparatus we soon found it necessary to observe four rules:

- 1 To distill slowly—this prevents excessive foaming.
- 2 To distill for 15 minutes into waste this acts to clean out accumulated products.
- 3 To deconcentrate with sufficient rapidity.
- 4 To clean entire apparatus regularly every 6 months, removing boiler scale and nitrogenous products.

Failure to observe any of these rules has resulted in reactions.

Since theoretically immediate sterilization should prevent formation of further pyrogen, the water was first distilled into a sterilization tank equipped with cooling coils. As soon as a sufficient amount of water was distilled it was sterilized and allowed to remain in the tank for 24 hours, except as used. We could demonstrate no

gross bacterial growth in this water yet after a week of use reactions began to occur and we found the tank walls covered by a nitrogen containing material. Repeated cleansing failed to keep this tank clean and it was therefore abandoned. A 5 gallon glass tank was employed but this developed the same difficulty so that water has since been distilled into glass graduates and immediately made up into solution. We found that in a warm room a delay of sterilization of as little as 4 hours could generate enough pyrogenic material to produce reactions.

The source of contamination and the point of trouble can easily be located by applying the permanganate test described by Carter to water in each stage of production. The test as described can be further simplified by using 10 cubic centimeters of water for the test and titrating this against two hundredth normal potassium permanganate in a clean test tube heating the water to boiling at intervals. If more than 1 cubic centimeter of permanganate is reduced the water is dangerous and if 5 cubic centimeters is reduced reactions are almost sure to occur. We have found this a very valuable test in locating the source of trouble when reactions occur. With the exception of a few instances when rules for distillation were badly disregarded, the distilled water has never reduced 1 cubic centimeter of the permanganate solution in this test. Obviously if the freshly distilled water is free of contaminant and reactions occur contamination source must be at some place during preparation of solution and by testing each stage the source can be located.

The preparation of the solutions next received our attention. By using the test just described it was found that if glassware was merely rinsed or imperfectly washed pyrogen might accumulate in it by bacterial growth in small residues, even in the moisture lining flasks. Accordingly strict rules were developed for cleansing of all glassware. The flasks and graduates are first washed in tincture of green soap and hot water and rinsed in tap water. The standard cleaning solution of potassium bichromate and sulphuric acid is then used. The glassware is next rinsed four times with tap water and six times with freshly distilled water. It is then ready for use. If not used within 2 hours the entire procedure is repeated.

The chemical ingredient of each solution is added to the graduate of distilled water stirred till dissolved and the resulting solution is then filtered through a fine filter paper. Erlenmeyer flasks of a size twice the capacity of the solution contained are used to prevent splashing during autoclaving.

In previous times ampuls of 50 per cent glucose had been added to the salt solution or to distilled water to prepare the glucose solutions. This appeared to us unsatisfactory fragments of glass from broken ampuls were constantly added to the intravenous solutions with small amounts of alcohol used to sterilize the ampuls externally and too sterility seemed questionable. Moreover each manufacturer claimed various advantages for his products and various staff members preferred different brands of glucose. Mallinckrodt's or Merck anhydrous chemically pure glucose bought in 100 pound lots and made up in our own solutions has proved very satisfactory and has reduced the cost of glucose solutions about 60 per cent. Glucose has been prepared in 5 and 10 per cent concentration. Sodium chloride is used in the usual tablets supplied by various manufacturers. The most used solution has been 5 per cent glucose in normal saline.

While seal with cork and paraffin seemed ideal from the point of view of permanency and completeness objections were raised by members of the hospital staff who insisted that solutions should be no more than 24 hours old. For this reason the conventional seal of gauze cotton and waxed paper has been used. As the use of fresh solutions has necessitated a great deal of waste we have been gradually increasing the length of time solutions may stand after sterilization without producing detrimental results and we hope soon to apply the cork and paraffin seal so that we may keep the solutions 30 days. We find that the longer solutions can be kept the less is the waste and the greater is the economy in labor.

The speed of injections, temperature of solution and amounts administered still persist in many minds as causative factors in producing unfavorable reactions.

Following the principles previously described almost all of our solutions are given at room temperature. Continued venoclysis is given without heating save for running the tubing along the patient's arm. We have never seen untoward effects of too cold solutions. Speed of injection has no effect on producing pyrogenic reactions as far as we can determine with the exception of the fact that fewer reactions occur with the use of venoclysis than in rapid intravenous injections. Pyrogenic reactions have, however been observed repeatedly after hypodermoclysis and certainly administration by this method is sufficiently slow.

The amount of solution administered may have a slight bearing. If 1,000 cubic centimeters of solution contains only sufficient pyrogen to cause

a reaction one half that amount should not do so. On the other hand with gross contamination quantities as small as 50 to 100 cubic centimeters can give severe reactions.

In our previous work we were inclined to disbelieve any possible effect of rubber tubing in causing reactions despite the previous work of others. The grounds cited was the boiling of rubber with non-pyrogenic solutions and administration to dogs without reactions. This has been repeated recently with four varieties of new tubing with the same result. Rubber tubing cannot be ruled out entirely on these grounds, however since dogs are relatively insensible to reactions. One of our wards has been especially equipped with an intravenous tubing sold by Becton, Dickinson & Company. This tubing far exceeds ordinary tubing in durability having withstood constant use for over 18 months without replacement. We have noted that although this ward used a great deal of intravenous fluid no reactions have occurred when this tubing was used. In many of the reactions recorded during the past year a history of new rubber tubing could be obtained. One particular instance presents some definite evidence that tubing may be an occasional causative factor.

A patient suffering from peritonitis after a ruptured appendix had received intravenous glucose and salt by venoclysis for 4 days without reaction. At this time the rubber tubing commenced to leak. The tubing was removed and a new set containing new rubber tubing was dropped into the same flask of solution previously in use and reconnected to the cannula in the vein. The patient received less than 100 cubic centimeters when a violent reaction occurred. Here all factors were unchanged except tubing.

Accordingly all our venoclysis sets and intravenous sets have been equipped with special Becton Dickinson & Company tubing and this is further prepared by the Stokes technique, namely filling the tubing with 10 per cent sodium hydroxide for 12 to 24 hours, washing in running water for 2 hours and boiling in distilled water for $\frac{1}{2}$ hour before using. Since this was done we have had but 3 reactions from some three thou-

sand liters of solution 2 of which could be definitely traced to the necessity of cleaning the still and all of which were mild. Rubber tubing offers another possible difficulty however in that it is frequently not sufficiently cleaned before using a second time, and contamination of the tubing occurs. This is especially true if a blood transfusion had been previously given. Scrupulous cleanliness and allowing waste of 100 cubic centimeters of solution through the needle before insertion into the vein are safeguards of this possibility.

RESULTS

Previous to the introduction of our new system infusions were sparingly given the clinician balancing always the beneficial effect against the dangers of reaction. The average consumption of intravenous solution was about 40 liters per month and reactions occurred in 30 per cent of these. Since installation of the new system consumption has gradually raised until at present about 600 liters are used per month. Reactions have varied from 4 per cent to none in the various months as we encountered the difficulties described. During the past 2 months one mild reaction has occurred in 1,033 liters of solution used. During the last 3 months our central supply room has taken over the making up of sodium citrate solutions for transfusions, and even here we have noted a great decrease in the number of posttransfusion reactions of pyrogenic type.

The constant rise in consumption of solutions indicates to us an increasing confidence on the part of clinicians in the safety of solutions prepared. A very occasional and mild reaction still occurs, but because of the rarity of these reactions it is extremely difficult to determine their cause. Perhaps individual susceptibility is the final factor over which we naturally have no control.

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POSTOPERATIVE SUPRAPUBIC FISTULA

ANALYSIS OF CAUSES

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AMONG the annoying and tantalizing complications of suprapubic cystotomy, whether done for obstruction of the neck of the bladder or tumor of the bladder is persistent fistulization or delayed healing of the suprapubic bladder incision. At times such incisions fail to heal and there is continuous urinary leakage; in other cases the wound opens and closes with intermittent urinary leakage. Fortunately after a careful study and recognition of the underlying cause most of these patients can be definitely cured and in our experience that has usually been the end result. On the other hand many patients have come to us in whom repeated attempts have been made to close the bladder fistula without satisfactory results.

During the last 20 odd years it has been possible in studying these cases to arrive at a pretty definite understanding as to the underlying causes of delayed closure and repeated re-opening of the suprapubic wound. The causes of this trouble seem to be local in the majority of cases, but in other cases, the trouble appears to be due to disease in the proximal part of the urinary tract, while in others the urinary tract distal to the bladder is the essential factor.

Among the local causes of persistent fistula or recurring fistula of the bladder the most common are connected with faulty technique of the operation, whether it be a one step or a two step prostatectomy or a resection of the bladder for neoplasia. As a result either of poor operative technique or of the patient's vomiting and coughing after operation, the bladder wall may prolapse between the rectus muscles with the result that a mucous membrane channel is formed which prevents the bladder from closing. In some cases the mucous membrane channel even grows out through the muscles and unites with the skin making a mucocutaneous fistula. It has been claimed by some that in opening the bladder, unless the incision is made high up near the dome fistulization is liable to occur but in our experience, irrespective of the site of incision, whether high or low fistulization seems no more likely to occur with the low incision, than with the high incision in the bladder wall.

Foreign bodies left behind in the bladder, either stones or secondary growths, or even real foreign

bodies, which become more or less encrusted with phosphatic material are occasionally found to lead to protracted slow closure of suprapubic wounds. Large diverticula of the bladder which have been overlooked in the course of the operation on the bladder whether for stone or prostatic enlargement, especially if infected are very liable to lead to slow healing of the suprapubic wound and often prevent definitive closure. After the diverticulum is removed just as in the other group after the foreign body is removed the suprapubic wound closes kindly much to the surprise of every one concerned.

In addition to the conditions mentioned small contracted, fibrous bladders are very liable to lead to repeated fistulization of the cystotomy wound and it is wise to avoid giving too good a prognosis in prostatic obstruction cases associated with contracted bladder both as to the cure of the contracted bladder and as to the relief of prostatic symptoms. Although one sees such cases completely relieved at times in most instances the contracted bladder never dilates properly and as the patient's capacity remains small the frequency persists and, unfortunately in these cases, fistulization is liable to be a disagreeable complication. In addition to this type of bladder a cystostomy in the presence of urinary tuberculosis is practically always followed by fistulization unless partial or complete exclusion of the tuberculous focus in the upper tract takes place.

Among the well recognized causes for fistulization of the bladder following cystotomy in the peripheral part of the urinary tract, are persistent obstruction at the neck of the bladder or in the urethra. Overlooked fibrous necks or overlooked prostatic adenoma masses are very liable to keep the suprapubic wound open, and naturally strictures in the urethra, stones in the urethra or other disturbances in the peripheral urinary tract, predispose to this disagreeable complication. These causes are rather well recognized and following transurethral section of the neck of the bladder with the electric cutting current, or dilatation of the stricture at the neck or in the urethra or removal of the stones, the suprapubic fistula usually closes and stays closed permanently after a brief use of an indwelling urethral catheter. In some rare cases neurogenic disturbances may

possibly underlie the delayed closure. In these disharmonies between the detrusor and sphincter muscles, the peripheral obstruction seems the important factor and it is relieved by use of an indwelling urethral catheter.

In the proximal part of the urinary tract, it is not generally appreciated that causes of continued and repeated opening of the bladder wound may be found. Infected calculous pyonephroses or infected hydronephroses, such as are occasionally seen after ureterovesical anastomoses, are not infrequent causes of persistent suprapubic fistula, and in our experience, after removal of such infected and infecting foci from the upper urinary tract either by nephrectomy or by more conservative means, it is surprising to see how frequently the suprapubic fistula will close.

In this brief analysis of the various local, proximal, and peripheral causes of persistent suprapubic fistula one must bear in mind that from the therapeutic standpoint our efforts must be of the simplest character while studying the case and deciding upon the cause of the trouble. Naturally if indwelling catheter with cauterization of the sinus from without and cytoscopically and occasional irrigations with silver nitrate solution of the bladder will lead to a closure of the fistula it would be unwise to rush in and do a large secondary operation to remove a diverticulum or to remove a kidney even if it be the site of calculous disease or be an infected hydronephrosis following some procedure on the ureter. If however local

measures, such as have just been mentioned, fail to effect a definite closure of the suprapubic fistula, it may be necessary to do something more radical which may consist of excision of the fistula and inversion of the bladder in mucocutaneous fistulae, or excision of the diverticulum in cases associated with infected diverticulum. In other cases, section of the contracted fibrous neck, etc., and again, in other cases, the removal of the infected and infecting proximal segment, kidney and ureter may be necessary before permanent closure of the fistula is obtained.

SUMMARY

Underlying causes of persistent and recurring suprapubic fistula following cystostomy

A. Local.

1. Improper surgical technique and partial prolapse of the bladder wall between the rectus muscles.

2. Stones, gauze sponges left in bladder

3. Contracted bladder.

4. Overlooked large, infected diverticula.

5. Disharmony between the sphincter and the detrusor muscles.

B. Peripheral.

1. Unrelieved obstruction at the neck of the bladder fibrous necks, adenomata.

2. Strictures, stones, etc. in the urethra.

C. Central.

1. Infected stone kidneys, infected hydronephroses, and tuberculous kidneys.

CORRESPONDENCE

ETIOLOGY OF GASTRIC AND DUODENAL ULCER

To the Editor: I would like to add my own results^{1,2} to the very interesting paper of Warren B. Matthews and Lester R. Dragstedt, in *SURGERY, GYNECOLOGY AND OBSTETRICS*, September 1933, p. 365.

Experimenting on dogs I found that ulcers in the duodenum (with the symptomatology of duodenal ulcer) could be produced in dogs simply by tying the

main pancreatic duct. These ulcers were confirmed by microscopic and histological examination. Melbourne Australia. J. LEON JONES.

JOHN B. MURPHY

Material is being collected for an authorized biography of Dr. John B. Murphy. If any reader of this Journal has in his possession letters from Dr. Murphy knowledge of facts concerning his life or any other data, it would be appreciated if they were sent to the Editors. All material will be returned promptly and the source credited.

JONES, M. J. Australia, March 2, 1935; April 19, 1935.
Lyon, An Experimental Study of Duodenal Ulcer. Melbourne, 1933.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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MAY 1933

CHRONIC ADHESIVE PERICARDITIS

FROM the standpoint of pathology there are three chief conceptions as to chronic adhesive pericarditis. In one there are adhesions between the heart and pericardium and also between the pericardium and surrounding structures especially the chest wall—mediastinopericarditis. In the second the pericarditis is a constricting one and, in the third, the adhesions are found between the outer layer of the pericardium and surrounding structures, especially the pleura, without any involvement of the inner layer of the pericardial sac. This latter condition is common in fibroid phthisis with pleuritis, and in tuberculosis confined chiefly to one lung and pleura thus causing moderate displacement of the heart toward the affected side.

In pulmonary tuberculosis the heart is usually small, either as a result of long rest, or because constricting pericarditis may be due to tuberculosis. This latter condition is rare, however.

The symptoms should make differentiation possible. In the external type of adhesive

tuberculous pericarditis with or without displacement of the heart, even if the shadow is small, there should be no essential cardiac symptoms. In constricting pericarditis, the symptoms are striking engorgement of the veins, chronic passive congestion, ascites and anasarca, together with other symptoms characteristic of broken cardiac compensation. There is this difference however, the heart is not hypertrophied and dilated as it would be if valvular or myocardial disease were present.

There is a widespread belief that suppurative pericarditis, in those patients who survive operation, is apt to be followed by disabling pericardial adhesions. It is natural to assume that drainage of the pericardium is followed by adhesions between the parietal and visceral layers and the leaving of drainage material in the pericardial sac should increase this likelihood. The writer has operated on eleven patients with suppurative pericarditis, with six recoveries. The patients who recovered were children or young adults and all were followed for some time. One the youngest, who was four years old at the time of operation, had a stormy early and late convalescence, for four months there were anasarca and ascites and the peritoneal cavity was tapped several times. For the last several years he has grown normally however, and there has been no clinical evidence of cardiac disability. One patient a nurse in training for about a year after operation, was short of breath on unusual exertion. She was without other signs, however, and is now without symptoms. Another, a six year old child, developed a secondary walling off in the pericardial sac high up and posterior, against

the left auricle which required a second operation. This pocket was located with the X ray and the examining finger introduced along the drain tract in the pericardium encountered fresh adhesions everywhere and was thrust through the wall of solid exudate into the pocket of pus. In spite of this, the child, after a slow convalescence was apparently well in six months and has since grown and behaved in a normal way. Two other patients were young adults and made good recoveries after a period of serious illness immediately following pericardiotomy. The last patient was operated on by a modified approach described elsewhere and made a more rapid recovery than any of the others. It was believed that better drainage was an important factor. He has been seen repeatedly and is not disabled.

One would expect to find after such operations, extensive adhesions between the outer layer of the pericardium and the chest wall and pleura, where these structures form the boundaries of the "triangle of safety" especially if no attempt is made to fasten the edges of the incised pericardium to the subcutaneous tissues. If such adhesions do occur the pathological findings should closely resemble the condition found in the mediastinopericarditis, and the disability resulting would call for the procedure of Brauer.

The pericardium follows the heart closely in its movements. It is easy to understand therefore that, if non-constricting adhesions occur between the two layers of the pericardium no very great handicap may be imposed upon the heart action unless the outer layer of the pericardium is adherent to the surrounding structures and, even then limitation of motion may not be marked unless the surrounding structures are unyielding. It is upon this assumption that the whole procedure of Brauer is based.

In my own experiences I have been surprised that pus escaping from the incision in the pericardium has not percolated into the middle mediastinum between the two pleura and the pericardium, or even into the posterior mediastinum, as the potential space between the two edges of the pleura just behind the sternum and in front of the pericardium (the "triangle of safety") is continuous with the middle and posterior mediastinum unless shut off by adhesions between the pericardium and pleura. There has been very little evidence that such an extension of infection has occurred, and no patient has as yet, presented any of the symptoms and signs associated with chronic adhesive mediastinopericarditis. I am quite sure that the outer layer of the pericardium does become to some extent adherent to the structures surrounding it, but I have not observed any evidence that there are adhesions between the pericardium and the unyielding bony and cartilaginous chest wall. It is certain that some individuals with rheumatic pericarditis develop widespread and dense adhesions between the heart and pericardium between the pericardium and surrounding soft parts and between these structures and the chest wall. Pericardiotomy with an open and discharging drain tract is bound to be followed by extensive infection. Just why dense and widespread adhesions are apparently not present as a postoperative complication is not at all clear.

One factor however, may explain much. The patients who recovered had suppurative pericarditis uncomplicated by empyema and, in most instances, the infecting organism was the pneumococcus. In the peritoneum and in the meninges, the pneumococcus causes a very fatal infection, but, in the pleura and in the pericardium, this infection is relatively less destructive of life. ARTHUR M. SMITH.

THE CHANGING TREND IN SURGICAL TECHNIQUE

IT is almost impossible for the busy worker in his generation to evaluate the changes that are constantly unfolding themselves before his vision. The more diversified these changes become, the greater is the difficulty of correct appraisal. It seems justifiable to remark that at no other time have changes in the social, economic, and scientific aspects of modern civilization progressed more rapidly than now. The practice of surgery shares equally in these changes. To many caught in the hurly burly of active life it is impossible, and probably seems unnecessary, to stop and scan the progress that is being made though it undoubtedly is wise to check up from time to time on the direction toward which general advances are being made and to emphasize the tendencies which seem to offer the greater progress.

Occasionally philosophical contributions to our surgical literature appear in which the author is courageous enough even to contemplate the future such as the delightful essay entitled *La Chirurgie de la Douleur* by René Lenche. Such a contribution must have for its inception a complete understanding of the actual state of practice in our time and represents a thoughtful attitude that in the long run is sure to exert a beneficial influence upon our field of work.

Recently driven by an interest in the surgical literature of that great epoch between the advent of anesthesia and the discovery of bacteriology I found myself plunged into that era of surgery in which great speed in operating was a dominant characteristic. This led to what I have chosen to call "ablation" surgery. Great portions of the body were removed rapidly with the knife in order to get rid of a small diseased part. This speed

was partly a legacy from the time when anesthesia was unknown and when speed in operating therefore diminished suffering. But it was also dictated by the fear of what might happen were the patient kept too long asleep, a fear engendered by the spectre of "ether pneumonia"! Lastly the speed represented the lack of a philosophical attitude toward the advent of anesthesia without doubt one of the greatest gifts our profession has ever made toward the comfort of man.

One of the chief tendencies in our modern development is the abolition of this attitude toward surgery. The enormous experience with modern anesthetics has given us great confidence in their safety and in particular the amount and duration of the anesthesia has been shown to play but a minor rôle in postoperative complications. Speed, once a necessity and therefore fashionable and popular, has been shown to be not only a non-essential but a positive menace. Surgery now rid of the specter of speed as a necessity has learned in this country largely through the influence of Halsted and his pupils a new, meticulous and gentle technique which considers every cell as valuable unless diseased.

To be sure amputations are still necessary, but they are performed in modern clinics only after every effort has been made to save the limb as a whole. This change of attitude toward the removal of major parts of the body is emphasized in the very critical studies relating to the possibility of restoring to a limb in which there is a damaged circulation sufficient blood supply to maintain the limb in a useful condition. The whole matter of sympathectomy in relation to impeded vascular channels and the great development of methods for testing the circulation of a limb and its possible restoration is an example of this. Technical improvements not only have permitted us this philosophical change toward

disease in surgical conditions but have enabled us to attack conditions heretofore too dangerous for operative intervention. Thus, the introduction of electrosurgery has enabled surgeons to attempt the removal of tumors such as those in the brain heretofore forbidden them. Whether the removal of such diseased parts is worth the price in suffering and economic loss, and result studies of survivals alone will tell.

This tendency for the preservation of all structures not actually diseased is constantly brought before us in the ever increasing and intelligent use of radiation in relation to tumors. Experienced surgeons fully appreciate the futility of surgical procedures in relation to certain very malignant tumors. Increasing diagnostic ability in which the X ray has proved of great assistance, has led to the early recognition of distant metastases, thus helping the surgeon to withhold a mutilating and useless procedure. Moreover we are now learning the great possibilities of radiation as a means of therapy in the treatment of neoplasms. So much have we learned of this that it may be said the day is almost at hand when the scalpel will not be considered in the treatment of certain of the more malignant sarcomata and embryonic forms of neoplastic growth.

Still more recently it has been shown that the eradication of certain congenital sinuses and fistulous tracts by a caustic solution may be a better method than the excision of these tracts with the scalpel. None of the methods are really new since the use of caustics and the cautery were methods practiced by Hippocrates and held equal position with the scalpel in the field of surgical therapy.

It appears that surgery today is characterized by a very sincere appreciation on the part of surgeons that every bit of tissue possible should be saved and particularly that structures taking part in important functions must be preserved. To this end we find introduced a great variety of new technical methods which seem increasingly to represent the one thing that has characterized the practice of medicine and surgery from a distant past, that is, to give to each individual patient the maximum benefit which can be given. It is perhaps surprising though surely worthy of our great tradition that in a day when scientific attitudes hold such a distinguished position in both the professional and public eye the profession of medicine in spite of its tremendous interest in the progress of science and its understanding of disease can still treat the patient rather than the disease.

ELLIOTT C. CUTLER.

EARLY AMERICAN MEDICAL SCHOOLS

THE COLLEGE OF PHYSICIANS AND SURGEONS OF CHICAGO

CHARLES DAVISON A.M., M.D., F.A.C.S. CHICAGO

Professor of Surgery Emeritus University of Illinois

THE College of Physicians and Surgeons of Chicago was incorporated October 14, 1881.

It was located at the corner of Harrison and Honore Streets, directly opposite the entrance to Cook County Hospital.

The College of Physicians and Surgeons was founded at a time when medical schools were largely proprietary institutions, owned and conducted by medical men. The founders were a group of young, active, pushing, ambitious medical men, experienced as junior members of the faculties of the existing medical colleges of Chicago. They sensed the timely opportunity for the entrance into Chicago of a new medical college. They appreciated the pedagogical value of graded courses of instruction. They recognized the proximity to Cook County Hospital as a great clinical teaching opportunity. They foresaw prestige and professional advancement for the members of the faculty of a new successful institution. They hoped for a profitable enterprise.

The original capital stock of the corporation was thirty thousand dollars, which was subscribed equally by the incorporators. Upon organization of the original faculty, the capital stock was increased to sixty thousand dollars, each additional member of the faculty being allotted stock to the amount of two thousand dollars.

The founders of the College of Physicians and Surgeons were A. Reeves Jackson, president, professor of surgical diseases of women and clinical gynecology, Samuel A. McWilliams, vice president, professor of clinical medicine, diseases of the chest and physical diagnosis, Daniel A. E. Steele, secretary, professor of orthopedic surgery, Leonard St. John, treasurer, professor of demonstrations of surgery, surgical appliances and minor surgery, and Charles Warrington Earle, professor of obstetrics. During the organization period there were added to the faculty, among others such well known men as Robert L. Rea, professor of principles and practice of surgery and clinical surgery, Frank E. Waxham, professor

of diseases of children, Henry Palmer, professor of operative surgery, clinical surgery and surgical pathology, John E. Harper, professor of ophthalmology, Oscar A. King, professor of diseases of the mind and nervous system, Henry Parker Newman, lecturer on obstetrics, Boerne Bettman, lecturer on ophthalmology and otology, G. Frank Lydston, lecturer on genito-urinary diseases.

The formal opening of the new institution occurred September 26, 1882, with 100 matriculated students present. The number of students in attendance gradually increased to 165, of which 52 graduated at the end of the session.

The clinical instruction to this class of students was given in the college amphitheater, the West Side Dispensary in the college building, the Illinois Charitable Eye and Ear Infirmary, and Cook County Hospital.

During the period of organization it was planned to present the entire subject of medicine in three annual pedagogically graded courses. The first year was planned to cover the fundamental subjects of anatomy, physiology, histology, chemistry, materia medica, therapeutics, and individual laboratory work; the second year to cover the principles of medicine, surgery, obstetrics, and the specialties; and the third year the practice of medicine, surgery, obstetrics, and their specialties, especially stressing a practical clinical training.

William E. Quine was appointed professor of medicine at the beginning of the second year, and thereafter the affairs of the institution were marked by his earnest, forceful, dominant personality. Nicholas Senn was appointed professor of surgery in 1882 and continued for 6 years with the institution. Christian Fenger, the great clinical pathologist and surgeon, was appointed professor of surgery at the beginning of the third year and occupied that chair for 9 years.

During the first 20 years the trials and difficulties of the college as a private institution were great. The administration of the institution was attended by ceaseless turmoil. There were fre-

quent changes in the faculty accompanied by great dissatisfaction, largely due to the policy which limited the faculty positions to those who owned the stock originally covering that particular subject. Charles Warrington Earle, who was one of the most stormy most persistent, and most capable of the objectors to the policies of the administration, was ousted. The college was not self supporting. The deficit at the end of 10 years was thirty thousand dollars.

At this crisis, in 1892 Dr Quine with the collaboration of Drs. Steele and Jackson, managed a reorganization. Charles Warrington Earle was made vice-president and professor of obstetrics, and Dr Quine president of the faculty. During this period there were notable additions to the faculty. John B. Murphy in clinical surgery, Henry T. Byford in gynecology, William A. Pusey in dermatology, Walter S. Christopher in pediatrics, Ludvig Hektoen and later William A. Evans in pathology.

A laboratory building with complete accommodations for the departments of anatomy histology embryology biology chemistry and pathology was erected and occupied in 1893.

The Quine Library, founded at this time became the depository of many medical books presented by Dr Quine and other members of the faculty and their friends.

The West Side Hospital was organized in 1896 by medical practitioners interested in the college, and soon became a center of college clinical activity.

These were years of material prosperity for the college there were more than 300 students in attendance in 1896. William A. Pusey was secretary. His vigorous activities added greatly to the prestige of the institution.

A new era in medical education was developing. The day of private medical schools was passing. The university plan of medical education was in evidence. The American Medical Association was demanding preliminary university training as an essential prerequisite. There was a general effort being made throughout the country to bring the well established independent medical schools into organic relationship with the universities. The Chicago Medical College, one of the earliest and best medical institutions in Chicago had been incorporated in Northwestern University as its medical department. Rush Medical College had affiliated with the University of Chicago.

Under these circumstances it was very reasonable that the University of Illinois should desire an affiliation with the strongest independent

medical institution in the state. It was very reasonable that the College of Physicians and Surgeons would welcome the prestige of a connection with the state university.

Acting upon a suggestion of Governor Altgeld to Dr Quine and to the board of trustees of the university an affiliation agreement between these institutions was signed April 1 1897. By its terms the College of Physicians and Surgeons was leased to the University of Illinois as its medical department for the period of 4 years. The medical college was conducted by the same individuals as officers and faculty but under the technical supervision of the University of Illinois. The university assumed no financial responsibility.

The results of this experiment were so satisfactory that an extension agreement was made for 25 years, beginning May 1 1900, at the termination of which ownership of the College and all of its property was to be vested in the university. During this period one-third of the net profits was to go to the university and two-thirds to the stockholders of the college corporation. The institution was designated as the "College of Physicians and Surgeons, College of Medicine of the University of Illinois." This arrangement was followed by an era of prosperity with a rapid increase in student attendance, reaching at one time a registration of 720.

Accommodations in the original building having become inadequate by agreement with the trustees of the university the adjoining public school property was purchased in 1900 by the college corporation and converted into a medical college building, thus greatly increasing the debt of the corporation.

The University Hospital was built and equipped by a small group of the faculty to provide more stable clinical teaching facilities.

The more rigorous requirements in medical education, the insistent demands for more adequate equipment and more elaborate methods of teaching increased the cost of administration. The requirements of higher standards of admission diminished the number of students and therefore the income. The financial condition of the college became almost untenable. To avoid the criticism that any appropriation by the legislature might directly or indirectly aid a private corporation, the 25 year partnership agreement was abrogated and a direct lease to the university of the college property for eighteen thousand, five hundred dollars a year was substituted.

Efforts by the university to obtain financial aid for the medical department from the legisla-



The College of Physicians and Surgeons of Chicago

ture failed on several occasions because of legislative technicalities and antagonistic litigation. No part of the general appropriation of the university could be used legally for the support of the medical school, the income of the medical school was derived entirely from student fees. The trustees had never expended a single dollar of money appropriated by the state to the university upon the medical department.

The existing conditions were so unsatisfactory to the directors of the College of Physicians and Surgeons that they decided to continue no longer the lease of their property to the university. Accordingly, President James discontinued the medical department of the university on April 30, 1912.

The announcement by Dean Quine that the medical school would no longer be leased to the University of Illinois and that the College of Physicians and Surgeons of Chicago would reopen its medical school caused great consternation among the faculty, students, and medical alumni. An active and influential group of the faculty refused to take part in the reorganization of the College of Physicians and Surgeons as a teaching body. These men hoped for the continuance of a medical school in Chicago under control of the University of Illinois. The annual election of the medical alumni resulted in an overwhelming victory in the interests of the university.

About this time it was suggested by President James that if it were possible for the medical alumni to gather up the stock of the corporation of the College of Physicians and Surgeons and present it outright to the University of Illinois together with the absolute ownership and control of the property it would be the best solution of the difficult problem. It would save to the university the fruits of its previous work in medical education, it would prevent the rivalry incident to another medical college being introduced into the field. It would bring back into the fold the friends of the College of Physicians and Surgeons, and it would furnish a plant already in existence under the absolute control of the university in which to conduct its medical work.

The alumni association recognized that to obtain all of this stock by donation or purchase in a limited time would require an unanimity of effort between the alumni, active friends of the university, and influential representatives of the College of Physicians and Surgeons. With this in view, a committee was appointed by the alumni association to take charge of the efforts to secure the stock for the university. This committee consisted of Edward Louis Heints, president of the Medical Alumni Association, D. A. K. Steele, president of the College of Physicians and Surgeons, and the writer, an ex trustee of the University of Illinois.

After an intense campaign by this committee, possession of the entire issue of stock of the College of Physicians and Surgeons was secured by donation, subscription and purchase, for a gift to the university. The complete stock issue of 2 170 shares of the Corporation of the College of Physicians and Surgeons of Chicago deeds to its real estate subject to certain encumbrances, a bill of sale of its personal property, its scholarship investments, its balance in bank (\$12 551 11) and the resignations of the officers of the corporation were delivered to the president of the board of trustees by this committee as a gift to

the University of Illinois from the Medical Alumni Association of the University of Illinois.

The board of trustees formally accepted the gift on behalf of the University of Illinois on February 12 1913, and directed the president of the university to reopen immediately the medical department.

The College of Physicians and Surgeons of Chicago passed out of existence when this transfer was completed. It has become a memory—a pleasant memory to some of the older members of its faculty increasingly pleasant with the reverse of the years.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

CHRISTOPHER'S *Minor Surgery*¹ now in its second edition promises to become one of the standard American textbooks on the subject. The thoroughness with which Dr Christopher has covered the literature is evidenced on every page and it is a pleasure to see that procedures and ideas emanating from other sources are duly credited, even though the author may not at times agree. Although numerous methods of treatment are frequently outlined for a single condition, Christopher indicates his choice and the logic upon which the choice has been made.

The book is profusely illustrated with numerous line drawings and photographs of diseased conditions and procedures. It would be very difficult to duplicate these illustrations without consulting many textbooks. The value of the book to the young practitioner and the interne is considerable since in it are described all of the minor surgical procedures and technical procedures which they are called upon to perform. Since the book is restricted to minor surgery it deals often with subjects which are but cursorily treated in textbooks of surgery. Genito-urinary, orthopedic, gynecologic, and rectal conditions so long as they belong properly to the realm of minor surgery are fully described thus making reference to special textbooks unnecessary. A broad conception of surgery such as Christopher has shown is both welcome and refreshing.

MICHAEL L. MASON

THE outstanding contributions to large bowel surgery by the Mayos, Judd and Rankin are epitomized in Rankin's recent book.² It will, therefore be widely read and constitutes a valuable reference book on this subject. Emphasis is placed on the importance of malignancy contributing two-thirds of the major lesions of the large bowel and rectum. Accepted methods of diagnosis and treatment are considered. In particular consideration is given to the roentgenoscopic examination of the large bowel which now permits accurate localization and recognition of the pathologic type in more than 95 per cent of lesions of the large bowel. Statistical data dealing with operability, operative mortality and longevity following surgical procedures

in malignancy, offer encouragement to patients so afflicted and reflect the advances made in the surgical management of these diseases.

The chapters on anatomy, physiology, and congenital malformation of the rectum are excellent both from the standpoint of text and illustrations.

The chapter on diverticulosis and diverticulitis is based on the study of a large number of patients and summarizes the many contributions to the subject of the Mayo group. The drawings illustrating the early beginnings of diverticula of the colon substantiate the Beer theory of origin namely that herniations of mucosa occur through weakened or fragmented circular muscle fibers of the large bowel.

In the treatment of megacolon the classical contributions of Judd and Adson and Rankin and Learmonth on lumbar sympathetic ganglionectomy are given careful description and illustration.

A detailed account is given of the bacteriological causes and experimental production of ulcerative colitis based on Bargen's work. While many workers in this field may not agree with the importance of the diplo-streptococci as a causative factor the evidence is fairly presented and therefore must stand the test of time and further study. The description and illustrations of the proctoscopic examination of the bowel with the varying changes in the mucosa in different stages of the disease are of great importance to the diagnostician. The entire chapter is one to be highly recommended to all those who have suffered with their patients in the treatment of this disease.

The chapter of polyps considers thoroughly the pathology and tendency to malignant degeneration of polyps which stud the whole colon from the caecum to the anus, in the condition known as multiple polyps. To the casual reader it may not be apparent that the pedunculated adenomata described under the heading of benign and rare tumors are by far the most common type of mucosal polyps found in the rectum and colon. These are often present in young childhood, and in the opinion of the reviewer are by gross and microscopic examination and course nearly always benign.

The material presented on cancer of the colon and rectum is splendid. It reflects the outstanding work in this field at the Mayo Clinic and presents a chapter of exceeding interest to all who are concerned in the surgery of cancer. If for no other reason these chapters fully justify the book. One of the outstanding contributions to colon surgery is Rankin's modification of the Mikulicz operation which he calls obstructive resection. A review of the rather dis-

¹Minor Surgery. By Frederick Christopher, B.S., M.D., F.A.C.S. With a foreword by Allen R. Kohn, M.D., F.A.C.S. 10 ed. Philadelphia and London: W. B. Saunders Company, 1934.

²THE COLON, RECTUM, AND ANUS. By Fred W. Rankin, B.A., M.A., M.D., F.A.C.S., J. Arnold Bargen, B.S., M.D., M.S. (Med.), F.A.C.S., Louis A. Eide, B.A., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1935.

encouraging results of cancer of the rectum by radium treatment is given by Bowing.

In discussing the causes of rectal stricture the authors properly throw doubt on the importance of tertiary syphilis as a causative factor. Lymphogranuloma inguinale and its identifying Frei test is not mentioned as a possible cause of rectal stricture, but it is of course true that this factor is not definitely established.

In the chapters given over to anal infections, pruritis ani, and hemorrhoids, there are numerous points where honest difference of opinion exists. For example, the author's statement that "the supposed incomplete external fistula is an impossibility" lacks authority.

The concluding chapter on operative procedures is well done and includes, as do most chapters in the book, a good bibliography. VENNON DAVIS.

THE authors of *Treatment of Syphilis*¹ have endeavored to present this important subject in as condensed and simple form as is possible. In this they have succeeded well. There are thirty-three chapters, eleven of which are devoted to the various methods of administering mercury in syphilis, the pharmacology and chemotherapy of mercury and the histological changes induced by it, and mercurial reactions, and their treatment. Two large chapters are devoted to blamuth therapy.

There are twelve chapters in which the arsenobenzenes are discussed. This discussion includes the history of their development, their chemotherapy and toxicity and the methods of their distribution and excretion. Reactions and fatalities following their use are thoroughly treated, and the technique of their administration is described in detail.

Two chapters are taken up with a discussion of the iodides and other metals, and one chapter is given over to the prophylaxis of syphilis.

The book is a fairly large one, and the subject is covered most thoroughly. The text is replete with references to the current literature, both foreign and domestic. The bibliography is indexed in an orderly manner and is a complete one. There are 63 excellent illustrations.

For anyone interested in the subject of syphilis, whether he be general practitioner or specialist, this book should prove to be of inestimable value. It is an excellent treatise and a distinct contribution to the subject of syphilis. EDWARD A. OLIVER.

IN his monograph² Rydberg has presented a very complete study of cerebral injury in newborn children from both the clinical and the pathological anatomical aspects. He lays a logical foundation for his study in a review of the normal anatomy and

histology of the cerebral structures. This portion of the work receives wider treatment than the main subject would seem to warrant. The author from his investigations agrees with the present accepted theories regarding the origin and development of the glial structures except in the case of the ameboid microglia. His observations on human and animal fetal brains reveal all evidences to be in favor of the common ectodermal origin of the whole glia.

He discusses at length theories dealing with the pathogenesis of intracranial bleedings in the newborn, and records theoretical and experimental observations as to the influence of the birth process upon the blood circulation in the fetus.

The author also records the anatomical observations on a series of autopsies upon 100 consecutive newborn fetuses dying during partus or within 10 days thereafter. He made a very complete gross and microscopic study of these specimens and has correlated them carefully with the clinical manifestations. The symptomatology and diagnosis of birth trauma brain injuries is thoroughly covered and chapters are devoted to prognosis and treatment of these conditions.

The case records of 50 cases observed by the author form an appendix of value to the obstetrician, the pediatrician, and the neurologist. The work is complete with a large and inclusive bibliography. HAIR HAYES.

THE new *Textbook of Pathology*³ by Boyd is admittedly not intended for practitioners of medicine or of pathology but for students of pathology only. The practitioner says Dr. Boyd in his preface, needs a book of reference. The student, on the other hand, needs a book from which he can gain a grasp of the fundamental principles underlying the subject. His time is too limited to permit its dissipation in "intriguing rarities or the newest notion of the moment." With this audience and these ideas in view Dr. Boyd has produced a textbook of pathology which is smaller by almost a hundred pages of text than any of the three best known textbooks on this subject now in use in America. The preface is not the least interesting part of the volume inasmuch as it gives a clear statement concerning the changed outlook of pathology and its relation to other branches of medical science.

In accordance with the usual custom in books on this subject this volume is divided into two parts. Part I deals with general pathology, which is the elucidation of the vital processes which underlie the end-results studied by the morbid anatomist. The study of disease from the physiological point of view. The book opens with a chapter on inflammation, which "forms the best starting point for the study of pathology as a whole." Without making inflammation a purposive reaction, the discussion emphasizes the functional side of all phases of the

¹TREATMENT OF SYPHILIS. By Jay F. Schindler, A.B., M.D. and Carroll R. Wright, B.S., M.D. New York and London: D. Appleton and Company, 1921.

²CEREBRAL INJURY IN NEW-BORN CHILDREN: CONSEQUENCE OF BIRTH TRAUMA WITH AN INQUIRY INTO THE NORMAL AND PATHOLOGICAL ANATOMY OF THE NEUROLOGIA. By Erik Rydberg. Copenhagen: Levin & Munksgaard, 1921.

³A TEXTBOOK OF PATHOLOGY: AN INTRODUCTION TO THE STUDY OF MEDICINE. By William Boyd, M.D., M.R.C.P., D.P.H., F.R.C.P. (Lond.), Dpt. Path., F.R.C.S. Philadelphia: Lea and Febiger, 1921.

process. The chapters on infection and immunity, degenerative processes, circulatory disturbances, animal parasites, infectious granulomata present clearly the important established facts concerning these subjects. The chapter on tumors is limited to 54 pages and is perhaps too brief, especially the discussion of some types of tumors, to give the student an adequate comprehension of the subject.

Part II, special pathology, begins with a discussion of the pathology of the heart and blood vessels and proceeds through the various organs and systems of organs. The section on nephritis is especially to be commended for both its brevity and its comprehensiveness. A helpful discussion of the newer established facts concerning the physiology of the female generative organs of bone and of the glands of internal secretion opens the chapters dealing with the pathology of these organs. Throughout the volume paragraphs on relation of symptoms to lesions should stimulate in the student an interest in the subject.

The literary style of the author is clear, concise, stimulating and interspersed with numerous striking bits of description and allusions that make the reading of this volume a pleasure. He speaks of cells "trapped in the pathless forest of the pulp" of the spleen. In connection with syphilis of bone he refers to "the nocturnal boring pains alluded to by the Psalmist." The incidental historical reference to the discovery of tar cancer on page 220 is especially interesting and should give to students a correct viewpoint toward research. The otherwise delightful literary style is marred by only one fault: namely the use of too many short sentences.

The volume can be commended for its clearness, its conciseness, and its readability. It will, on most subjects, meet adequately the needs of medical students. It may also be read with profit by practitioners of medicine and surgery who desire to indulge in the periodic brain-dusting recommended by Osler¹ and to acquaint themselves with the modern point of view of pathology which is no longer "an outworn creed, a science as dead as the material with which it deals." Pathology in relation to the living patient is the motif of this book. The subtitle, "An Introduction to Medicine," is therefore justified.

J. P. SIMONDS.

IN a 325 page monograph¹ Grollman discusses the subject of the amount of blood pumped by the heart in unit time. Dr. Grollman is associate professor of physiology in the Medical School of Johns Hopkins University and has devoted a number of years to this type of study. The book contains a critical review of the various methods formerly in use and a detailed account of the acetylene method.

The physiological variations of the cardiac type as studied by this method include the effects of posture, ingestion of food and fluids, sleep, menstrua-

tion, emotion, temperament, exercise and altitude. Another series of studies were made of the changes of cardiac output considering the effects of alcohol, caffeine, tobacco, carbon-dioxide, adrenalin and the vaso-depressants. The cardiac output was studied in various types of cardiovascular diseases and abnormal cardiac physiology.

The bibliography is complete and the book is well indexed. The printing and binding are excellent. It will be of particular interest to those who are active in research in cardiovascular physiology in the clinic or in the laboratory. CHAUNCEY C. MANER.

ENDOCRINE medicine is discussed by Engelbach¹ in a 3 volume work of over 1800 pages profusely illustrated. The first volume on general considerations covers the research history, anatomical development, physiology of the endocrine glands, the etiology of their diseases, diagnostic procedure and the relation of endocrine disorders to public health. The second and third volumes are composed of four main sections in which endocrine diseases of infancy, juvenility, adolescence and maturity are discussed. The emphasis throughout the work therefore is on the life-long character of the endocrinopathies and on their appearance in all age periods. This point of view is in some part due to the demonstration of the growth hormone. Abnormality of this function of the anterior pituitary must be determined by comparison with a normal curve of growth. A valuable feature of this work is the inclusion of tables of measurements and x-ray studies of bones from infancy to maturity. The prominence given the infantile and juvenile endocrinopathies is justified by statistical analysis of the 3000 cases which make up the clinical basis of the book. Of the diseases occurring in this series 40 per cent were believed to have started in infancy or childhood. It is axiomatic in general medicine that prevention is the best treatment; obviously in this group of diseases prevention of adult disorder begins during embryonic life; hence the endocrine status of the mother must be analyzed and corrected. To follow out the same line of thought, a section on senility should be added.

The adult endocrinopathies covered in section five are thyroid disorders, hypophyseal disorders, composed of anterior lobe pituitarism, adiposogenital pituitarism, pituitary tumors, and neuro-pituitary disorders, bi-glandular disorders of the thyroid and pituitary, gonadal disease, and thymic syndromata. Parathyroid conditions, covered originally as they appear in infancy and childhood, are again described in a single chapter relating to adolescence and maturity. In this discussion tetany and hyperparathyroidism are presented.

¹ ENDOCRINE MEDICINE. By William Engelbach, M.D., F.A.C.P., B.S., M.S., D.Sc. With a foreword by Leighton F. Barker. Vol. I.—General Considerations; Vol. II.—The Infantile Endocrinopathies. The Juvenile Endocrinopathies; Vol. III.—The Adolescent Endocrinopathies. The Adult Endocrinopathies. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

THE CARDIAC OUTPUT OF MAN IN HEALTH AND DISEASE. By Arthur Grollman, Ph.D., M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1932.

Throughout all sections case histories are used, charts given, X-rays and histological sections reproduced, and therapeutic experience quoted. The hormone preparations now available are evaluated and indications for their use given.

The complete picture of endocrine physiology and disease in man will not be presented for many years. At the present time this work describes well known endocrine entities in the light of the latest discoveries but, in addition, will have a permanent place in medical literature because of its teaching of the endocrinopathies as life-long processes beginning in infancy and continuing on through childhood, adolescence, and maturity.

A fourth volume is being prepared for the diseases of the pancreas, suprarenals, and liver.

PAUL STARR.

AZEMA presents a comprehensive monograph¹ on spondylolisthesis. After a short historical review he enters into an extensive discussion of the lumbosacral anatomy and the mechanics resulting in the anterior displacement of the vertebral body. The influence of the upright position in the production of spondylolisthesis is emphasized. Attention is called to the loss of bony continuity at the isthmus (pars interarticularis) of the lamina and the loss of rigid support at the base of the vertebral column. After a very thorough portrayal of the clinical manifestations of this condition, the author describes the methods of treatment and adds a surgical procedure of his own. This monograph is well illustrated with many diagrams, photographs, and roentgenograms. An excellent résumé of the subject of spondylolisthesis to the present date.

FREDMONT A. CHANDLER.

A DISTINCT need in experimental pathology has been filled in the small volume² by Wagoner and Cuarter. The frontispiece is a portrait of Julius Friederich Cohnheim, the most eminent of Virchow's pupils, who by brilliant experiments on living animals revived a pedantic subject and demonstrated to others a method of investigation which, in a few brief years, has yielded incalculable benefits to mankind.³ The book is divided into three sections. The first deals with surgical technique and experimental methods, anesthetization of the experimental animals, general care of the experimental animal, and normal blood findings in laboratory animals. The general principles of surgical technique are briefly but adequately described, and the different types of knots and sutures are well illustrated. The necessity of care in anesthetization is strongly emphasized. In the foreword Professor Krumbhaar remarks, except for the appalling ignorance in some non-medical circles of the conditions under which animal experimentation is carried

on, it would be unnecessary to mention that absolute asepsis, general anesthesia, and similar precautions are carried out wherever indicated, with as strict conscientiousness as in the human operating clinic. In fact, such conditions are usually essential to the success of the experiment as well as obligatory from humane points of view. The second and third sections are concerned with methods of producing general pathological conditions and lesions of special organs. One hundred and nineteen experiments are described clearly and in such adequate detail that they can be carried out by any intelligent student. Most of the procedures for inducing pathological conditions have been well selected. Many of the more complicated methods, such as Mann's technique for inducing gastric ulcer by various types of gastric and intestinal anastomoses, have been omitted. The typography is excellent. Large, clear type and heavy unglazed paper render reading easy. The binding in heavy brown Holliston book duck is admirable for rough use in a laboratory. Following the descriptions of many experiments one or more references are given to important papers which will aid the student in technique and, especially, in interpreting his results. As there is no book of similar scope in English, this volume will be welcomed by teachers who wish to introduce their students to the field of experimental pathology either as a special elective course or as an accessory to the routine teaching of general and special pathology. J. P. SIMMONS.

THE book⁴ by Crile and his associates is not a formal treatise on the thyroid gland but as its preface states, is an account of the experience of the staff of the Cleveland Clinic in the treatment of diseases of that organ. In a sense then it is a binding together of many small articles—some profound, others very superficial. Dr. George Crile, Jr., writes the chapter on iodine and the thyroid gland. Dr. D. Roy McCullagh a short summary of the biochemistry of iodine. Dr. Crile writes on the rôle of the thyroid gland in the energy system, on endemic goiter, and on the mechanism of hyper and hypothyroidism. Dr. Charles L. Hartsock discusses clinical aspects of hypothyroidism. Drs. Tucker and McDonald briefly describe the diagnosis of hyperthyroidism. Dr. E. Perry McCullagh writes a valuable chapter on the differential diagnosis of hyperthyroidism. Dr. Robert S. Dinamore writes briefly on hyperthyroidism in children. No careful analysis of the physiologic results in this interesting field is given. Dr. John P. Anderson writes briefly on cardiac disturbances associated with hyperthyroidism. Two good articles are those by Dr. A. D. Roodman on ocular changes in hyperthyroidism, and by Henry J. John on carbohydrate metabolism in hyperthyroidism. A valuable treatise on roentgenological observations in thyroid disease by Dr. Bernard H. Nichols, well illustrated with X-ray films, serves to

¹ *By Spondylolisthesis*. By Marc Azema, M.D., F.R.C.S. and Company 1932.

² *A Handbook of Experimental Pathology*. By George Wagoner, M.D., and R. Philip Cuarter, M.D. With a foreword by Edward Ball Krumbhaar. Springfield, Illinois: Charles C. Thomas.

³ *Discussions on Treatment of Diseases of the Thyroid Gland*. By George Crile and Associates. Philadelphia and London: W. B. Saunders Company 1932.

emphasize the importance of substernal goiter. Malignant and inflammatory conditions of the thyroid are discussed in a series of chapters. Operative technique is described and illustrated by Dr. Dinamore. Special considerations in the technique are discussed in a separate chapter by Dr. Crile. The diagnosis and treatment of parathyroid tetany is covered in a good chapter by Dr. E. Perry McCullagh. The book concludes with a short chapter on end results of operations for hyperthyroidism by Dr. George Crile.

On the whole the book is, of course, interesting and a variety of illuminating studies from unusual angles are gathered together here. In general, however, one would conclude that most of these studies are too brief and too superficial to be of much value. The book is of interest to the student of thyroid diseases but not the authoritative treatise with which one would begin the study of those disorders.

PAUL STARR.

A BRIEF review of the most important advances in obstetrics and gynecology published in the past few years is contained in the third edition of the book¹ of Bourne and Williams. The book is written in a simple and direct manner as a coherent text and not merely as a collection of abstracts. New material has been added on the subjects of anæsthetics in labor, carcinoma of the cervix, and functional uterine hemorrhage. There is also a chapter on the X-ray in obstetrics and gynecology which is illustrated with excellent prints. The book bears evidence of thorough revision of previous editions and will prove valuable to the physician who wishes to keep abreast with the growing literature.

IRVING F. STEIN

THE work² of Wuerdemann now in its second edition is still the only book in English since that of Ramsay in 1907 devoted to the subject of injuries of the eye. The text has not been materially lengthened and the number of illustrations has been reduced by more than one hundred. Those which are retained are of good quality, however, and are for the most part original. The paper and type of the present edition are excellent, a great improvement in these respects over the first edition.

The author shows his familiarity with the German and French literature and acknowledges his debt to

RECENT ADVANCES IN OBSTETRICS AND GYNECOLOGY. By Aleck W. Bourne, M.A., M.B., B.Ch. (Camb.), F.R.C.S. (Eng.), F.R.C.O.G., and Leslie W. Williams, M.D., M.S. (Londn.), F.R.C.S. (Eng.), M.C.O. 3d ed. Philadelphia: F. Blakiston's Son and Co. Inc., 1933.

INJURIES OF THE EYE: DIAGNOSIS AND TREATMENT, FOREIGN PROCE-
DURES AND VISUAL ECONOMICS. By Harry Vanderbilt Wuerdemann, M.D. 2d ed. F.A.C.S. 3d ed. St. Louis: The C. V. Mosby Company, 1933.

the large work of Wagenmann. He has also drawn from a large personal experience and many of the conditions described are illustrated by case histories, giving treatment and results. In removing foreign bodies from the eye by the electro-magnet the author prefers the anterior route, as a rule, by which the body is drawn around the lens into the anterior chamber, whence it is removed by corneal incision. The importance of X-rays in every case of suspected or even possible foreign body is emphasized.

Eighty pages are devoted to medicolegal questions, including important legal decisions and an abstract of the Workmen's Compensation Laws of the various states as they affect ocular injuries. Under these laws, compensation for loss of both eyes (total disability) varies from one thousand dollars (Georgia) to fifteen thousand dollars (South Dakota) averaging six thousand dollars. That for loss of one eye varies from six hundred dollars to two thousand eight hundred and eighty dollars, averaging about two thousand dollars.

One misses from this book a consideration of some important recent work. Nothing is said about injuries with tear gas, especially as to the use of sodium sulphite in glycerine as a solvent which was described by McNally. In considering enucleation of the globe and its substitutes, no mention is made of simple evulsion with retention of the cornea, an exceedingly valuable procedure. The operation described by the author is the old one with removal of the cornea, to which his disparaging remarks may well apply.

SAMUEL R. GIFFORD

THE monograph³ on acromegaly by Atkinson is one of those concise but exhaustive collections dealing with a particular disease that no one interested in the subject can afford to be without. It is a straightforward presentation of all the reported findings, gathered from an exhaustive analysis of the world's literature. It consists of two main parts—a series of chapters presenting the findings of different authors concerning the historical, clinical, pathological, diagnostic, and therapeutic aspects of the disease, and a series of analytical tables covering the results of removal of the pituitary gland, the post mortem findings, the eye findings, a tabulation of certain features of the 1,310 cases that the author has collected from the literature and finally a bibliography covering 63 pages. I am impressed with the thoroughness and clearness with which this review is presented.

PAUL STARR.

¹ACROMEGALY. By F. R. B. Atkinson, M.D., C.M. (Edin.). With a foreword by Sir Arthur Keith. London: John Bale, Sons & Danielsson, Ltd., 1932.

BOOKS RECEIVED

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skin glands which are classified morphologically as acinous and tubular glands. Functionally they are divided into sebaceous and sweat glands. The breast is a modified sweat gland.

In an early stage of the embryo the ventrolateral surfaces of the body show a broad linear band of high epithelium generally known as Schwalbe's milk streak. The first anlage of the breast in humans appears in the last half of the second month of fetal life. Numerous puctuate epithelial thickenings are visible along the milk streak. They are known as milk points or mammary fields and consist of circumscribed epidermic proliferations in the shape of a tiny mound. These milk points are quite prominent in human embryos ranging from 28 to 60 millimeters in size. In so much as only one pair of breasts are ordinarily present in newborn and adult humans, the other anlagen are presumably those of supernumerary breasts because they are of similar histological make-up and correspond to the natural locations of aberrant breast tissue when it does occur. In the early stages of development, the mammary gland corresponds very closely to the origin and differentiation of sudoriparous glands. The sweat glands adjacent to the breast appear much later in the embryo but in significantly close relationship. The primitive breast differs from the early sweat glands only in the exceptional size of its tubules.

In the fifth month of fetal life, the lentil shaped plaques in the malpighian layer of the epidermis, which we have referred to as milk points begin to invaginate and dip down into the underlying connective tissue as solid cords which later acquire lumens. The milk point contains a basal layer of cylindrical cells with oval nuclei, the longitudinal axes of which are in a vertical plane. External to these cells are several rows of small polygonal cells with round nuclei. These solid cellular cord-like proliferations originate from the cylindrical cells in the superficial epidermic plaques. These proliferations become club shaped and extend farther downward into the connective tissue where they branch off into similar solid secondary buds. In the meantime, the connective tissue surrounding these

cords thickens and forms areolar tissue. At this stage in the development of the breast the tubules do not differ from the ducts of the meibomian glands, the early hair follicles or the sweat glands. The primary cords or tubules later develop hair follicles with corresponding sebaceous glands and the secondary buds divide into the ducts of the breast proper. These ducts extend deeply into fatty tissue which is arranged in embryonic fat islands. Toward the end of fetal life there is formed in many places, especially in the middle part of the tubule, a differentiation of the layers corresponding to those of the large sweat glands so that eventually the ducts contain two layers of cells an inner secretory layer and a basal layer such as in the adult gland. The blind tubules in the resting stage do not show the typical acinous structure until later life when they become functional.

Kolliker and Benda are both agreed that the breast is of sweat gland origin. The abundant histological evidence in the breast justifies this belief. Rudimentary sweat gland structures can be found in almost every breast, if diligent search be made. Some of the tubules of sweat gland origin developing beneath the areola of the breast empty into the mammary ducts rather than on the surface of the skin in a manner similar to the primitive hair follicles. The hair on the glandular field usually disappears in the progress of development together with the accompanying sebaceous glands. The sweat glands may or may not remain if they do they retain their ordinary relation to the lacteal ducts. This anatomical arrangement, as will be shown later accounts for the occasional occurrence of sweat gland adenomata and carcinomata immediately beneath the nipple.

There are at least five different interpretations of the significance and histogenesis of the so called sweat gland anomalies in the breast either normal sweat glands, sweat gland cysts, or sweat gland tumors.

a. Extramammary sweat glands of the skin are said to be included accidentally in the tissues of the mammary gland as aberrant cell rests (Creighton).

b. The sweat gland structures represent an arrest in the development of the breast in

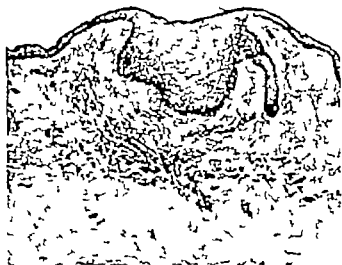


Fig. 1. Development of breast. Human embryo 14 centimeters in length. The milk point or anlage of the breast, showing it to be a cutaneous merocrine gland. Note the basal columnar cells and superjacent polygonal cells with round nuclei in the rudimentary nipple. The early lacteal bud is morphologically indistinguishable from a primitive sweat gland tubule.

these locations at a phylogenetically early stage which we may call the sweat gland phase i.e. incomplete mammary differentiation. Von Saar was first to correlate these structures with sweat glands, he believed that they indicate "a phylogenetic level at which the breast tissue had differentiated itself from sweat glands."

c. The sweat gland tubules, cysts and tumors in the breast are atavistic phenomena due to metaplastic changes in the lacteal ducts, which become dedifferentiated into an embryologically earlier cell type (Prym Dreyfuss).

d. True sweat glands are normally present in every breast where they anastomose with and empty their secretions into the interlobular lacteal ducts (Ewing).

e. The pale epithelial cells comprising these structures are said to be entirely unrelated to sweat glands. The morphological changes and peculiar staining affinities are attributed to degeneration of these cells in which they simulate but do not constitute sweat gland epithelium (Dawson).

It seems fundamentally unimportant to us to determine whether these peculiar mammary structures are anomalous embryonal, normal, or degenerative. The major premise has been that the breast is a modified sweat gland, the



Fig. 2. Development of breast. Human embryo 14 centimeters in length. Another milk point showing several lacteal ducts which have acquired lumens. At this stage the resemblance to sweat gland tubules is obvious and significant.

appearance of apparent sweat gland tubules and cysts in the breast is a logical occurrence even though the mode of origin remains in dispute. It is significant to us that the anatomical and staining characteristics of these cells remain through all the transitional phases of normal sweat gland tubules, cysts, intracystic papillomata, adenomata, and car-

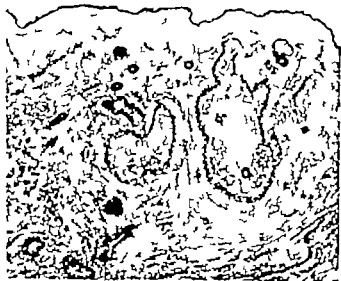


Fig. 3. Development of breast. Human embryo 11 centimeters in length. Intermediate differentiation of the breast. Serial section to show the early anastomosis of sebaceous glands with lacteal buds. These sebaceous glands and the numerous hair follicles seen at this stage are transitory and are not found in this close relationship in the fetus at term. At the base (arrow) a duct with two cells layers can be seen. It is of typical sweat gland structure.



Fig. 5 Cystic sweat gland tubules in a normal breast. The adjacent lacteal lobules stand out in marked contrast to the sweat gland tubules, because of the difference in size, structure, and staining qualities of the cells.

cinomata. This maintenance of cell type in the evolution of sweat gland tumors is a strong argument against the degenerative theory. Careful microscopical scrutiny of serial sections of these breasts frequently reveals the site of anastomosis of lacteal and sweat gland ducts. The abrupt transition in the character of epithelium lining these ducts is noteworthy if the process were degenerative it would probably not be confined so exactly to this duct system. Our studies have confirmed the theories of Ewing in regard to the histogenesis of these structures.

One is impressed in studying the structure of the developing mammary gland in the fetus, by the large size and abundance of sweat glands in the skin surrounding the breast. We believe it to be significant that the sweat glands of the newborn as compared with the adult are relatively enormously hypertrophied.

The development of the sweat glands in the skin corresponds in miniature to the development of the breast proper. The majority of sudoriparous glands originate on the finger tips, palms and soles in the fourth month of fetal life. Their anlagen resemble closely those of the breast. They project downward

as solid bulbous papillae the terminations of which become tortuous in the sixth lunar month. Intercellular clefts appear in the seventh month to form a continuous lumen in the tubule. At this time the distal end of the tubule becomes convoluted as in the adult sweat gland. In the axillary and inguinal sweat glands the tubules branch and form secondary buds as they do in the breast. The epithelium of the sweat gland duct acquires two distinct layers, an inner large celled secretory layer and an outer flattened myo-epithelial layer. The number of sweat glands in the skin are definitely determined at birth as are the number of hairs.

ANATOMY AND PHYSIOLOGY OF THE ADULT BREAST AND ITS RELATION TO SWEAT GLANDS

We have previously stated that sweat gland tubules are found in almost every breast. They seem to be more common in subjects with oily skin and considerable body hair and who are predisposed to acne and sebaceous cysts. The number of these sweat gland tubules in the breast is extremely variable. In some patients there are many and in others there are relatively few. Their locations in the breast correspond with the regional distribution of sweat gland cysts and sweat gland cancers in this organ namely in the axillary segment submammary fold and margins of the breast as well as immediately beneath the skin of the areola.

It appears evident that there are two types of ducts within the breast the lacteal ducts which form the bulk of the functioning glandular tissue and the occasional irregularly distributed sweat gland ducts. Hereafter in our discussion we shall employ the terms lacteal ducts and sweat gland ducts to distinguish these two structures. The investigator will find in serial sections of the breast that sweat gland ducts anastomose in the majority of cases, with the normal lacteal ducts. The mammary gland never presents typical entirely normal coiled sweat glands in its deeper structure. These sweat gland ducts represent various transitional stages from primitive sweat gland epithelium to normal lacteal epithelium. Such transitions may be observed in the ducts of the same breast.



Fig. 6 Two tiny cysts in a breast which is the seat of chronic cystic mastitis or Redus disease. The cyst of the lacteal duct is lined by epithelial cells in two orderly layers, a basal germinating layer and an inner secretory layer. The cytoplasm of these cells is lilac colored and neutrophilic. The cyst in the adjacent sweat gland system in the breast illustrates the peculiar histologic features of hidradenoid cysts. The eosinophilia, the intracystic papillary tufts, the plication or infolding of the epithelial lining, and the disposition of the club-shaped columnar cells are practically never found in cysts of lacteal ducts, but are commonly observed in apocrine sweat gland cysts of the axilla, groin, and scrotum.

The lacteal ducts of the mammary gland are lined either by a single, or more frequently a double row of columnar cells. They possess a relatively broad lumen. The membrana propria is supported by a connective tissue wall containing both longitudinal and circular elastic fibers but no muscle. The outer row is lower than the inner one. On the contrary there is only one epithelial cell layer in the alveoli, the structure of which differs during various functional states. Around the alveoli there may be found a small number of elongated stellate cells sending out long fine processes the so called basket cells the nature of which is in dispute.

The sweat gland ducts in the breast can easily be differentiated from the lacteal ducts by ordinary tissue staining. The inner secretory cell layer is not cuboidal or flat, but is composed of high columnar stratified epithelium with a tendency to papillary formation which is never seen in normal lacteal duct. These cells may be piled up on each other in the form of terraces. The staining peculiarities are quite striking. The cytoplasm of these fine canals which with even



Fig. 7 High power magnification of wall of sweat gland cyst in Figure 6. The cytoplasm of the club-like or columnar cells is granular and eosinophilic. The papillae vary in size and structure they commonly have sparse stroma and occasionally they exhibit an arcade towering or stratification of epithelium. The so called myx epithelial cells are not well shown in this section but in the deeper tissue there can be seen a thin encircling band of smooth muscle fibers. Muscle tissue is not found in connection with lacteal cysts or ducts except in the region of the ductal ampulla.

stain pink or even light red. This eosinophilia can best be appreciated in comparing sweat gland ducts and lacteal ducts in the same microscopical field. We are presenting a colored illustration showing this difference in the staining affinities of sweat gland epithelium and lacteal epithelium, in this picture the sweat gland duct is seen emptying into a lacteal duct (Fig. 4 frontispiece). At the site of anastomosis the transition between eosinophilic cells and neutrophilic cells is abrupt. Sweat glands in the normal skin have eosinophilic cytoplasm which characterizes the sweat gland ducts in the breast substantiates to some extent the homologous origin of these structures. Goldzieher and Kaldor on the other hand interpret this eosinophilia as a metabolic change in the lacteal cell which causes it to resemble sweat gland epithelium, they offer no evidence however to substantiate their opinion.

Another anatomical analogy which exists between the sweat glands of the skin and the sweat gland structures within the mammary gland is the frequent association of smooth muscle cells with the membrana propria of sweat glands of the skin and sweat gland structures in the breast. There are no muscle cells lining the lacteal ducts but smooth



Fig 9. Sweat gland adenoma in the skin overlying a carcinoma of the breast. The two tumors are adjacent but separate. The sweat gland tubules are enormously multiplied and cystic. This finding illustrates the consistent adherence of histogenic type in the benign and malignant sweat gland tumors of the breast (from Krompecher)



Fig 10. Sweat gland adenoma in the skin overlying a carcinoma of the breast. The muscle fibers characteristic of sweat glands and their neoplasms are plainly visible (From Krompecher.)

ing the acini of these ducts are the so called basket cells, first described by Langhans in 1873. These spindle or stellate cells are found side by side in parallel arrangement and are bounded on the outside by the structureless stratum of the membrana propria and on the inner side by the epithelial layer. Their occurrence in the terminal vesicles is denied by Creighton and Benda and asserted by Nagel and Kuru. They are interpreted as smooth muscle cells by Kuru, Heidenhain and Benda. A definite fibrillation can be made out in these cells similar to that seen in other muscle cells; their staining reaction is also considered characteristic of the latter. As to their function it is believed to be that of contracting to express secretion from the ducts. In accordance with this view of their origin and character they have been designated as myo-epithelial cells. No cells of this character are visible surrounding the lacteal ducts proper but they are so frequently found surrounding the sweat gland ducts in the breast and are such an integral part of the sweat glands of the skin as to be considered characteristic of these structures. Kolliker in 1849 first

demonstrated the presence of smooth muscle cells arising from the outer epithelium of the sweat gland ducts in the skin. Kolosow in 1896 found persistent structures corresponding to these muscle cells in the breast proper. This muscle network is best shown in the sweat glands of the snouts in many animals.

There has been considerable argument as to whether or not these cells are actually smooth muscle cells. Some histologists have doubted this theory of their nature and have assumed that they are cells corresponding to ordinary mesenchyme, which somehow have become closely approximated to the ducts and alveoli. Such a conception has been expressed more recently by Diechmann (1925). Others believe that these cells line capillary spaces running parallel to the wall of the ducts or cysts. Whatever their true character may be it seems significant that they are found fairly constantly in the sweat glands of the skin and are frequent in the sweat gland ducts of the breast. It was this analogy which prompted Benda to be the first to postulate the theory that the breast is a modified sweat gland. He found that the large sweat glands of the axilla and certain ducts in the mammary gland have in common an inner layer



Fig. 11. Wall of a sweat gland cyst in the breast. Immediately beneath the stratified epithelial cells are numerous fine muscle fibers, presumably of the myo-epithelial type. (From Krompecher)



Fig. 12. Part of three sweat gland cysts of the breast. The "pale" columnar epithelial cells are shown in papillary and arcade formation. Radiating from the membrana propria of one of these cysts are many fine muscle fibers (From Krompecher)

of secreting epithelial cells and this outer layer of supposedly contractile muscle or myo-epithelial cells. The reason for the persistence of these peculiar cells in the sweat gland ducts of the breast and their absence in the lacteal ducts is that they represent a vestigial relic or survival of the earlier necessity for the contraction of ducts and expression of secretion which is not necessary in the human breast. Smooth muscle fibers are found within the nipple and within the adjacent portions of the areola of the normal breast. These are arranged in circular bundles at the base of the nipple the longitudinal fibers within its substance diverging into radiating bundles within the subcutaneous tissues of the areolar zone. Contraction of these fibers elevates and hardens the nipple, thus simulating the action of erectile tissues. In some way, this phenomenon is related to the action of the muscle fibers surrounding the sweat glands of the skin and aiding the excretion of sweat.

The sweat glands of the areola lie deeper than the sebaceous and Montgomery glands. They are found in the loose connective tissue between the base of the nipple and the glandular portion of the breast proper. This tissue is traversed by the true lacteal ducts 12 to 20 in number and it is around these vertical ducts that the small sweat glands are dis-

tributed. As we have previously stated, they may at times empty into these lacteal ducts rather than on the surface of the nipple. Creighton found them uniformly in six breasts which he examined. Krompecher and later Colin found sweat gland adenomata arising in this location and we have observed sweat gland carcinomata apparently arising from these structures.

In discussing the theory of sweat gland cancers of the breast and their relation to sweat glands of the breast we have been questioned about the distribution of sweat glands in the mammary skin. They are most abundant in the submammary fold and in the axillary segment and their function of secreting sweat is related somewhat to the menstrual cycle of the patient. In many women the breasts become moist when the rest of the skin is dry; this is particularly true at the onset of the menstrual period when the breasts enlarge, and the nipples readily become erect. In other words, the secretion of sweat on the breast and lactation by the breast are stimulated similarly by ovarian secretion. The activity of the sweat glands in the mammary skin was well



Fig. 13. Sweat gland carcinoma of skin of shoulder. Note the close histological resemblance to certain cellular or medullary varieties of mammary cancer.



Fig. 14. Sweat gland carcinoma of skin (not of breast). To show the infiltration of carcinoma cells among smooth muscle fibers which frequently surround sweat gland tubules.

shown by Sir Astley Cooper who studied the secretion of sweat in the skin of the breast after death. If the breast is wiped dry then compressed it will continue to perspire after being dried several times. This is observed more especially if the cuticle has been separated by putrefaction.

The mammary gland was formerly thought to be the homologue of sebaceous glands and the production of milk a process analogous to the activity of the latter. Gegenbauer even assumed a diplectic origin of the breasts in different species. He believed that the breast in certain of the lower animals developed from primitive tubular glands of the sweat gland type whereas the breasts in other animals above the Monotremata in evolution have acinous lobular structure finding homology in the sebaceous glands. This theory is unsound and not substantiated by our studies. The secretion of the sebaceous glands entails a destruction or decomposition of the gland cell called by Virchow 'necrobiosis.' The lactating mammary glands never show stratification and subsequent destruction of the secretory cells which further disproves this theory. Kolliker and Virchow to the contrary. The manner in which the sweat gland secretes is not thoroughly known but there is sufficient evidence at hand to warrant the conclusion by anatomists and physiologists, that secretion occurs by the separation of soluble chemical substances from the cells.

The nuclei of the cells become pigmented and fat accumulates in the cytoplasm and is therein transformed into secretion. The process of secretion does not entail any destruction or even substantial changes in the sweat gland cell. Heldenbain found the breast to secrete in a similar manner except that it has differentiated to such an extent that it can secrete fat. Functionally both the sweat glands of the skin and the breast are merocrine glands in that they are secreting epithelial cells and do not undergo necrobiosis. The breast may therefore be defined as a modified sweat gland of the skin secreting milk, the unique component of this secretion being fat.

APOCRINE AND EXOCRINE SWEAT GLANDS—THE BREAST AS AN APOCRINE SWEAT GLAND

There are two different types of sweat glands in the skin. The numerous small sweat glands with terminal coiled tubules, which are widely distributed over the entire body and are particularly frequent on the palms, soles, and face are termed exocrine sweat glands. Departures from the usual structure of these sudoriparous glands occur in certain regions of the body. If we except the eyelids with their specialized sweat glands (of Moll) these locations are the mammary and axillary regions, the scrotum, the inguinal folds, the labia majora, and the anus. According to Robin certain parts of the side of the face contain these glands, where they are mixed

with the other sweat glands in the proportion of 1 to 10. According to Sappey in the first edition of his treatise on anatomy these large sweat glands may range widely over the lateral and anterior thoracic walls. These latter sweat glands known as apocrine glands differ markedly from the common sweat glands of the skin. They are relatively very large and their tubules have secondary ramifying ducts similar to the racemose arrangement of the mammary gland. The inner secretory epithelium of the apocrine sweat glands is composed of dilated columnar cells with eosinophilic cytoplasm and a tendency to papillary formation. They are histologically similar to the sweat gland tubules found in the breast; therefore it is assumed that the breast originates from the apocrine type of sweat gland.

The fundus of the small exocrine sweat glands is a smooth coiled tubule with a narrow lumen, whereas the apocrine sweat glands of the axilla are made up of racemose tubules that evaginate forming wide saccules.

The exocrine glands which carry the major burden of the secretion of sweat and the regulation of the body temperature are highly functional in children. The apocrine sweat glands are closely related to the sex glands and their development is largely in abeyance until puberty is reached. In the female the apocrine glands of the axilla begin to enlarge in the ninth year but in the male they do not take on their secondary growth activity until the time of puberty (Luneberg 1902). These axillary sweat glands occur in the midst of great numbers of small exocrine sweat glands. The apocrine glands are composed of an inner layer of high eosinophilic secreting cells and an outer single layer of myo-epithelial cells.

As further proof of their relation to the sex glands in common with the breast it is of interest to know that the apocrine sweat glands are stimulated or depressed according to the various stages of the menstrual cycle. Not only do these apocrine glands become more prominent at puberty in common with the breasts and other genital apparatus but they undergo enormous hypertrophy during pregnancy along with the breast and uterus and other genital structures. The secretory activity of the axillary sweat glands increases

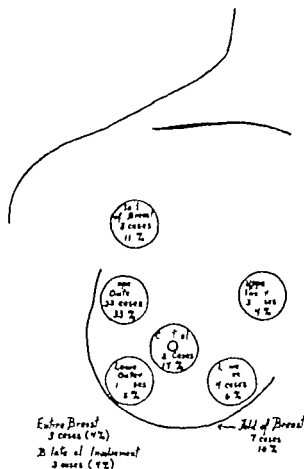


Fig. 15. The regional distribution of sweat gland carcinoma of the breast. Note the preponderance in the margins and tail of the breast.

during the lactational period. The secretory activity of the axillary apocrine sweat glands regresses within a fortnight after the cessation of nursing and the loss of stimulation induced by suckling. The apocrine sweat glands of the axilla in humans occur in greatest abundance in a definite patch in the apex of the armpit usually not more than an inch in diameter and one-tenth of an inch thick. The enlargement of these axillary apocrine glands during pregnancy may reach the size of a hen's egg and they may be erroneously diagnosed as aberrant breast tissue or polyastia. This diagnosis is made the more readily because they may secrete a thin opalescent fluid which contains colostrum corpuscles. The difference between these functioning hypertrophied apocrine sweat glands during pregnancy and the slightly more developed aberrant breast tissue in the axilla is very slight from the standpoint of histogenesis. The secretion from the axillary and



Fig. 6 Primary bilateral sweat gland carcinomata of the breasts in the same patient. In the right breast, the tumor is situated in the submammary fold, in the left breast the tumor is located in the axillary tail, both common sites of predilection for sweat gland cancers. Note the early marked attachment to skin.

Inginal apocrine glands even in normal conditions is different from sweat in other parts of the body. Another argument substantiating the relationship of these glands to the sex glands in common with the breast is the fact that the odor from these particular sweat glands provokes sexual stimulation in certain of the lower animals.

Apocrine sweat gland cysts of the axilla occur occasionally. Primary adenocarcinomata may occur in these cysts. The possibility exists that some of the primary cancers in aberrant breast tissue in the axilla may originate in apocrine sweat gland structures. Tiny sweat gland adenomata are often found in the skin of the scrotum and penis.

COMPARATIVE ANATOMY OF THE BREAST PHYLOGENETIC RELATION TO SWEAT GLANDS

The order of mammalia takes its name from these specialized cutaneous glands or mammae. The character and complexity of the breast



Fig. 17 Superficial ulcerating sweat gland carcinoma of the breast. The location and ulceration of this lesion are characteristic of but not peculiar to sweat gland carcinomata.

changes markedly from the primitive tubular glands of the lower orders of mammals to the human breast yet the fundamental structure and function remain essentially the same.

In the *Echidna*, which are *Monotremata* and the lowest order of mammals, there are no sweat glands on the entire body except a few in the immediate vicinity of the breasts. This remarkable anatomical fact strongly suggests that these surplus sweat glands are genetically related to the mammary glands in this animal. The deposit of large sweat glands under the areola in man is very likely a by-product in the evolution of the breast from these primitive types. The opposite condition obtains in the *Ornithorhynchi* where the mammary organs have appropriated actually all of the sweat glands on the ventral body surface. In certain of the plated animals, the breasts are not developed as isolated discrete organs, but the secretion of a milk-like pabulum occurs over the major portion of the body surface and the young obtain their nourishment not by suckling but by licking this sticky secretion as it appears. In the *Cetacea*, large muscle-walled sweat glands of the apocrine type are found near the mammary slits and on the vulva, although they occur nowhere else in the cetacean skin.

The excretory cutaneous glands of amphibians (e.g. frogs) are of the same two varieties as found in human skin—a common small gland secreting a clear watery or mucinous product and a larger specialized kind occurring only



Fig. 18



Fig. 19

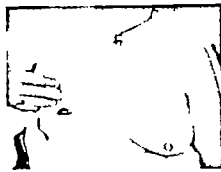


Fig. 20

Fig. 18. Primary inoperable sweat gland carcinoma of axillary tail of breast.

Fig. 19. Early sweat gland carcinoma of the submammary fold, verified by microscopic examination. The clinical features of this lesion closely simulated traumatic fat

necrosis of the breast, which is also of frequent occurrence in this region.

Fig. 20. Sweat gland carcinoma of the submammary fold of the breast, which is infiltrating and ulcerating the skin.

in certain regions of the body and secreting and opaque white substance the analogue of true milk. The thumb gland which occurs only in the male frog has a functional and structural resemblance to the apocrine sweat glands. This thumb gland is a true sexual organ and enlarges considerably during the breeding season. It is a racemose tubular gland with a myo-epithelial cell layer similar in every respect to the apocrine glands of the human groin and axilla.

The breasts of marsupials such as the kangaroo are within a ventral pouch which harbors the immature fetuses. At the time these tiny immature fetuses attach themselves immovably to the nipples which nourish them the secretion of the breast is mucinous and the structure is primitive, as the young develop the breast and its secretion undergo corresponding modifications so that its structure is more complex (i.e. acinous rather than tubular) and the lacteal fluid approaches the composition of milk. It may be said therefore that the breast of the kangaroo during a single lactational period exhibits the various evolutionary changes seen in all the species of mammals, from the simple primitive gland of the sudonparous type to the complex organ characteristic of the higher vertebrates.

Moles are said to have few sweat glands of either kind while the closely related shrews have a great sexual development of the large apocrine glands along the flanks. Creighton has called attention to certain accessory

sexual glands in the hippopotamus which secrete the so called bloody-sweat of that species. This fluid is a glairy substance the color of diluted port wine. The glands which secrete this liquid are branching tubular apocrine glands situated on certain parts of the dorsal surface of this animal. They are not accessory breasts but are phylogenetically related to the breasts.

Creighton has given a good conclusion which we shall quote in part. The true milk gland of the higher classes retains traces of its descent from sweat glands found either in the convolute tubular type of its rudiment and the muscular basement of its ducts or failing the latter in a basal layer of epithelial cells in the ducts. The muscle cells are very prominent in the more primitive types but with the development of acinous lobules this muscular element tends to be lost. What really distinguishes the human breast from the monotreme mamma (and the still more primitive sweat glands) is the acquisition or addition of acinous lobules in which the milk is secreted. The foundation of original tubules is retained for ducts."

SWEAT GLAND CYSTS AND ADENOMATA OF THE BREAST

Our knowledge of sweat gland structures in the breast and their histogenetic significance has been obtained largely through microscopical study of cystic diseases of the breast. The majority of investigators have studied 'sweat gland cysts' rather than



Fig. 21. Ulcerating sweat gland carcinoma of the submammary fold of the breast. Figures 20, 20, and 21 illustrate different stages in development of the sweat gland cancers of this region.

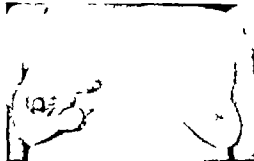


Fig. 22. Recurrent inoperable sweat gland carcinoma of right breast. The entire breast is involved by a diffusely infiltrating duct carcinoma. Once the sweat gland carcinoma is fully established, its local and systemic behavior is similar in almost every respect to the more common cancers of the lacteal gland.

sweat gland carcinomata on this account we shall give a detailed historical résumé of their researches.

The names of three men in particular are associated indelibly with the theory of sweat gland cysts and sweat gland carcinomata of the breast. Krompecher in Germany Creighton in England and Ewing in the United States. The latter has had great experience with these sweat gland cancers. It has been our privilege to review his abundant material. Mansell Moullin in 1881 described pea sized cysts in the mammary gland which were surrounded by parallel hoop-like rows of spindle cells. Although not identified as such, these cysts filled all the histological requirements of sweat gland origin. This is the first report we have been able to find in the literature wherein these peculiar structures were recognized. Juengst in 1884, described similar cysts accompanying an intracanalicular myxoma of the breast. It remained however for Krompecher in 1897 to identify these cystic structures as sweat gland cysts and to formulate the theory of histogenesis of sweat gland tumors. Dawson erroneously ascribes this original discovery to Borst who in 1904 demonstrated some mammary fibroadenomata which in circumscribed places showed large irregular pale cylindrical cells with compact homogeneous cytoplasm and nuclei of different size. These polymorphous high cylindrical cells with occasional giant nuclei were often arranged in stratified arcade like columnar epithelium. Von Saar in 1907 reported two mammary cysts lined with large

cells, containing a bright red fine grained protoplasm; the cells never formed true vessel-bearing papillae although they were stratified in papillary tufts. Von Saar designated these cells as "pale epithelium" to distinguish them from the basophilic cells of the lacteal epithelium. Billroth found these peculiar cysts most commonly on the extreme periphery of the breast from which he inferred that a lobule here or there had failed to develop normally.

Krompecher's researches deserve a thorough summary. The cystic disease of the breast variously known as the *maladie kystique* (Reclus) cystadenoma (Schimmelbusch) and *mastitis chronica cystica* (Koenig) is neither a tumor nor an inflammatory lesion according to Krompecher but it is an anomaly of the mammary gland consisting of small cysts analogous to sweat gland cysts. This author designates this disease as hydrocystoma mammae multiplex and points out its morphological correspondence to the cysts of the axillary sweat glands. The first beginnings of this so called hydrocystoma of the breast consisting of such typical sweat gland cysts lined with pale epithelial cells and appearing grossly as bluish or greenish transparent vesicles from a millimeter to a centimeter in size are not infrequently found as Krompecher observed at autopsies in apparently normal female breasts. He found them in well developed as well as in involuted breasts and occasionally in adolescents. Even the male is not exempt from this disease as Krompecher has reported a typical case of sweat gland



Fig. 23. Papillary cystadenocarcinoma of breast sweat gland type. Low grade of malignancy (grade one plus or two minus) because of the degree of differentiation. It is quite radiosensitive. Its vulnerability is attributed to the character of the stroma rather than to the carcinoma cells *per se*. The tumor is mostly intracystic and intra ductal.



Fig. 24. Duct carcinoma ("comedo"-carcinoma) of sweat gland type. This histological variety of cancer is frequently found in lacteal ducts as well as in sweat gland ducts. In the latter case the ducts are gigantic and the carcinoma cells are larger and more conspicuously eosinophilic than in the lacteal duct cancers.

cyst of the breast in a male subject. The minute histological description of the cysts as given by Krompecher agrees in every particular with our own microscopical studies. The considerable size of the cells, the knob-like or clubbed protuberances of the cylindrical epithelium, the abundant compact homogeneous pale eosinophilic cytoplasm and the small round and occasionally giant nuclei comprise a characteristic microscopical picture. The peculiar pale epithelium of the cysts and tubules is very sharply differentiated from the lacteal epithelium and the excretory ducts of the breast. The cell boundaries are frequently indistinct and the adjacent cells in such cases appear to be confluent, forming giant polynuclear cells. Krompecher noted (and we have many times confirmed this observation) that the sweat gland epithelium in the breast is especially inclined to proliferate and form papillae. The majority of the papillary cystadenomata of the mammary gland originate from lacteal epithelium, but there are many others of the sweat gland type (Fig. 6). Krompecher found this pale sweat gland epithelium as the basic structure in 21 cysts, 12 benign fibro-adenomata, and 9 cancers in the group of 292 benign and malignant breast tumors comprising his material. In only 3 of the cancers, however, was he able to demonstrate the characteristic long

spindle cells running in parallel groups around the basement membranes.

Kuru observed this 'pale epithelium' in 3 breast tumors and emphasized the relative smallness of the nuclei. Von Saar likewise referred to the close similarity of the mammary cysts to the sweat glands in which the resemblance extends to the fine details of histological structure. Although we have emphasized the occurrence of sweat gland cysts in the microcystic variety of Reclus disease (non-inflammatory fibrosis), we do not mean to infer that they are pathognomonic for this disease because the majority of the cystic structures are lined by ordinary lacteal epithelium.

The specificity of sweat gland cysts in the breast is generally recognized by the French school. Roussy states in his recent textbook on cancer that there is normally a mixture of two kinds of glandular tissues in the breast: one, the acinar glandular groups of the lacteal type, and another of ramified ducts of the sudoriparous type lined by tall pyriform eosinophilic cells and occurring commonly in the axillary region. Letulle terms these sweat gland cysts of the breast 'idrosadenoides'.

Our youngest patient with sweat gland cysts of the breast was 26 years of age. Herzenberg found numerous pea-sized red nodules in both breasts of a stillborn infant



Fig. 5. Infiltrating sweat gland carcinoma of the breast. Typical structure of many of these cancers. Marked eosinophilia.



Fig. 6. Infiltrating papillary adenocarcinoma of the breast of the sweat gland type. Grade two plus. Radio-sensitive.

The nodules when examined microscopically proved to be cystic apocrine sweat glands.

We have seen sweat gland cysts and lacteal cysts immediately adjacent to each other and in several instances have been able by serial sections to trace these cysts and tubules to the point of anastomosis with lacteal ducts. Cheate likewise states that in serial section he has always been able to trace these cysts of the sweat gland type into the ducts of the breast. Semb found the pale and normal epithelium merging directly into each other in the same cystic duct of the breast. Although this may occur it is unusual more commonly an entire branch of a duct and its ramifications are completely involved in the process.

Presumably the factors predisposing to sweat gland cysts are the same as in lacteal cysts of the breast. Similar cysts have been produced experimentally in extramammary sweat glands these cysts are microscopically identical with the so called sweat gland cysts of the breast. The experiments of Schildach were successful in producing cysts of this type. He made semicircular linear incisions through the skin of the paws of narcotized cats, about the level of the excretory ducts of the sweat glands and parallel to the surface of the epidermis. The partially severed discs were then sutured back onto the paws the cats were given pilocarpine solution to stimulate the secretion of sweat and 3 to 9 weeks later were killed. On microscopical examina-

tion hydrocysts of the sweat glands had originated directly from the excretory ducts and resembled in every respect the sweat gland cysts found in humans, especially in the axilla and breasts.

In a recent article, Dawson vigorously attacks the hypothesis that these structures are of sweat gland origin. He asserts that the pale epithelium commonly identified as sweat gland epithelium is not related at any stage with sweat gland tissue and that it occurs in the breast too frequently to warrant the supposition of accidental inclusion as a developmental anomaly. He observed these cells in 120 breasts with malignant tumors and in 48 breasts with benign cysts all of which had the entire breast minutely examined microscopically in whole breast sections. We quote one of his arguments as follows. "An important and essential point to note is that in all cases this pale epithelium in the breast lines a definitely cystic structure, although the size of the cysts may vary within wide limits. Even the smallest pale structures are always larger than normal mammary acini." Dawson's assertion that these pale structures are found invariably associated with the formation of cysts in the breast is not substantiated by our studies (Figs. 5, 8 frontispiece 9). This difference in size, although a distinguishing feature does not necessarily indicate that the so called sweat gland tubules are cystic and degenerated as compared with the smaller lacteal tubules. In the human



Fig. 27. See clinical photograph Figure 21. Alveolar sweat gland carcinoma of breast. Grade two. Moderately malignant. Some papillary structure.



Fig. 28. Medullary sweat gland carcinoma of breast. Grade two plus. With increasing anaplasia the cells tend to lose their eosinophilia; this change is more apparent than real because the nuclei are larger, the cell bodies are smaller, and eosinophilic cytoplasm is less conspicuous.

breast the lacteal tubules are largely excretory ducts and their lining epithelium is not highly functional whereas the primitive tubules such as the sweat gland structures are assumed to be lined by high columnar secretory cells. An analogy exists in the case of the developing kidney. The secretory units of the primitive kidney become the collecting tubules of the mammalian kidney and are morphologically quite different from secretory units such as the convoluted tubules. The sweat gland tubules have not differentiated sufficiently to be anatomically and functionally similar to the lacteal epithelium.

It is true that cell degeneration with the formation of cysts is more common in sweat gland structures in the breast than in the other mammary tissues. This is frequently the case in embryonal anomalies and should not be considered as evidence that all these sweat gland structures are degenerative. Many sweat gland cysts contain cell detritus made up of the desquamated pale epithelium.

Dawson presents another argument for the degenerative theory by calling attention to the fact that pale eosinophilic glandular epithelium has been observed in the ovary, uterus, prostate, and kidney all of which are the site of possible cystic degeneration. Dawson furthermore states "The onset of the pale change is post-proliferative and an evidence of a checked and receding epithelial activity." We have previously stated that sweat gland cysts and tubules are character-

istically prone to form papillary ingrowths yet we have never seen these structures prior to the supposed change wherein the epithelium becomes eosinophilic. If Dawson's observations are true we should see this many layered proliferating epithelium before it degenerates and becomes eosinophilic. Furthermore all stages of the transition should be visible and we would not expect to see the uniformity in structure which the sweat gland tubules and cysts constantly show in serial section. It is our belief therefore that the eosinophilia and other anatomical characteristics of these cells precede and accompany the proliferative changes.

There are numerous other theories extant to explain the presence of these structures in the mammary gland. McFarland has considered them to be residual (i.e. non involuted) lactation acini, although many pathologists have discovered them in non lactating virginal and even infant breasts. Prym considers the pale epithelium as metaplastic mature breast tissue predominantly acinar tissue.

SWEAT GLAND CARCINOMA OF THE BREAST

Krompecher was the first to observe the cancerous transformation of the pale epithelium characteristic of sweat gland tubules and cysts. He commented on the active participation of the pale epithelial cells of these cysts and the intracanalicular cystadenomata in

the carcinomatous proliferations. The eosinophilic cells form stratified layers and papillae within the cysts occasionally even blocking the lumina and forming pale epithelial nests and alveoli. According to this author these relations demonstrate that both intracanalicular cystadenomata and true carcinomata can originate directly from the pale epithelium of the sweat gland cysts.

Berk studied the intracystic papillary formations in sweat gland cysts and considered the process as something intermediate between metaplasia and anaplasia. Furthermore he noted a close resemblance of these large pale eosinophilic cells to certain atypical elements in large cell carcinomata of the breast without however showing definite malignant growth. Charteris studied whole sections of 48 breasts removed for carcinoma. He saw these pale cells of the sweat gland type and even noted the development of carcinoma from them.

(Other pathologists are definitely opposed to the theory that these sweat gland cysts with intracystic proliferations are precancerous and even deny that carcinoma ever developed from this pale epithelium. Von Saar in particular states that no direct transformation of these cells into carcinoma has ever been confirmed.

Dawson calls attention to the rarity of sweat gland carcinoma of the skin; he found only one specimen of this type in 13,500 pathological lesions studied. Because of this fact he cannot understand why the malignant possibilities of these so called sweat gland structures should be so much enhanced when they supposedly form a normal inclusion in the breast substance. Contrary to this view it is our opinion that sweat gland ducts and cysts in the human breast should be even more prone to undergo malignant degeneration because of the well known tendency of aberrant primitive and embryonal structures to become malignant.

Dawson has classified the conflicting opinions concerning the nature and possibilities of the 'pale epithelium' into two definite groups, namely (a) The pale epithelium indicates a proliferative change with a more or less definite possibility of later malignant development (Krompecher Borst Ewing Cheate

and Cutler Creighton) (b) The pale epithelium indicates a proliferative change with later and progressive degeneration (Von Saar Theile Deaver and McFarland Blood good Prym).

Although Theile once observed an actual transition from pale epithelium to carcinoma he states that he found in the pale epithelium no specific kind of cell 'but only a degeneration form originating under certain external conditions, which are distinguished from the normal gland cells by a stronger growth energy (formation of epithelial papillae) and secretory activity (vacuoles) or even by a briefer period of life. We cannot comprehend how a cell can exhibit 'stronger growth energy' when it is degenerating. It seems more likely that the eosinophilic character and the large size of the pale cells are characteristic of the sweat gland epithelium in as much as they persist in the majority of cases after malignant change has supervened. In Cheate and Cutler's experience this peculiar staining property of the pale cell disappears when the neoplastic stage is manifested. A study of our material shows that this change occurs especially when the carcinoma becomes increasingly malignant and exhibits anaplastic tendencies. Thus we have several specimens in which a fairly well differentiated sweat gland carcinoma has the large pale eosinophilic cells in certain regions, while in other portions of the same carcinoma the cells are smaller more hyperchromatic, less differentiated and presumably more malignant.

It is our opinion that the sweat gland features of these structures in the mammary gland may be found in all pathological stages, from the normal breast microcystic disease of the breast benign tumors, and precancerous intraductal papillomatous processes, to carcinoma. A recent specimen in our selection exhibits all of these stages in sweat gland cysts: an intraductal papillary cystadenoma and a true sweat gland carcinoma. It is unlikely that the cysts, the intraductal cystadenoma, and the carcinoma have all undergone degeneration simultaneously and uniformly throughout. Mitotic figures found in the eosinophilic sweat gland cells verify their active participation in cell multiplication and

the growth of the carcinoma. Dawson maintains that these mitotic figures represent "agonal mitoses" in dying cells.

The first detailed and accurate description of the growth and microscopic pathology of sweat gland carcinoma of the breast was reported by Ewing. This author states that a considerable proportion of mammary cancers arise in sweat glands of the breast, in his material, this proportion is in the neighborhood of 25 per cent. We have recently analyzed a group of 166 histologically verified primary operable carcinomata of the breast and in this group 41 or practically 25 per cent, were of the sweat gland type. The sweat gland cancers of the breast may be either cystic or solid. Aside from their peculiar distribution in the breast there are few distinguishing features of this type of mammary cancer except that they are usually more yellow than other mammary carcinomata. Ewing attributes this yellow color to xanthomatous changes which are more frequent in sweat gland cancers than in other varieties.

Our material is the same from which Ewing made his original observations. He found that the majority of the papillary cystadenocarcinomata and the glandular adenocarcinomata with cuboidal clear cells and basophilic cytoplasm develop from the lacteal ducts whereas the sweat gland ducts of the breast give rise chiefly to papillary and adenocarcinomata in which the cells are columnar rather than cuboidal. These cells are predominantly eosinophilic. Some of the comedo carcinomata or duct carcinomata are of this type although in such cancers the ducts are usually much larger than in the case of carcinoma of the lacteal ducts. The tendency of the sweat gland carcinomata to form papillary structures is in keeping with this same inclination of the sweat gland cysts and tubules.

The eosinophilia of the cytoplasm in the well differentiated sweat gland carcinomata testifies to the sudoriparous origin of these cells which is further emphasized by the presence of certain cells of the myo-epithelial type arranged in a comb-like fashion at the periphery of the neoplastic nodules. These cells are found only rarely and then only in those cancers which are not invasive and do

not destroy the integrity of the surrounding breast tissue. The myo-epithelial cells are either not reproduced in the rapid growing sweat gland carcinomata, or if they are present, they are not recognized as such.

Some of the sweat gland carcinomata in our collection are made up of clusters of large alveoli lined with one or occasionally two rows of opaque eosinophilic cells with supporting cells lying on a well defined basement membrane. The morphological and staining characteristics which distinguish them from other carcinomata of the breast may be lost in the anaplastic varieties, this is quite evident in studying the metastases from such cancers. Except for these properties which we have enumerated the sweat gland carcinomata of the breast have much the same structure as other mammary cancers, indeed, we find that the bulky adenocarcinomata the comedocarcinomata the papillary intraductal and intracystic adenocarcinomata, the medullary carcinomata the carcinoma simplex and even scirrhous carcinomata of the breast are represented in this group although the distribution is not the same as in the case of carcinomata arising from the lacteal ducts.

We have shown in our clinical analysis of 81 cases of sweat gland carcinomata of the breast that this tumor is more frequently adherent to the skin than is the ordinary breast cancer. Pain occurs in only 8 per cent of the general group of mammary cancers whereas in the sweat gland carcinomata of the breast it is the predominant symptom in 34 per cent of the patients. Approximately two-thirds of these carcinomata were situated in the periphery of the breast, where the apocrine sweat glands are most abundant. We sometimes find these sweat gland carcinomata in the subareolar region adjacent to the great ducts near the nipple.

CLINICAL REPORT OF EIGHTY-ONE SWEAT GLAND CANCERS OF THE BREAST

Age. The average age of 2,663 patients with mammary cancer who applied to the Memorial Hospital was 51 years; this same age was also the average for the 81 patients with sweat gland carcinoma of the breast. The oldest patient with any type of mammary

Age group	Carcinoma of the Breast		Sweat Gland Carcinoma of the Breast	
	Number	Per cent	Number	Per cent
Under 25	8	0.3	1	1.2
25 to 29	51	1.9	2	1.2
30 to 34	156	5.2	5	6.2
35 to 39	266	10.0	5	6.2
40 to 44	384	14.4	20	12.4
45 to 49	443	16.7	24	17.3
50 to 54	480	18.0	23	16.0
55 to 59	335	12.6	14	17.3
60 to 64	254	10	2	14.9
65 to 69	156	6.0	1	1.2
70 to 74	95	3.6	3	2.7
75 to 79	51	1.9	0	0
80 to 84	23	0.9	2	2.4
85 to 89	5	0.2	0	0
Totals	2503	100.0	81	100.0

cancer was 90 years and the youngest 17 years while the eldest patient with sweat gland cancer of the breast was 84 years and the youngest 19 years of age. The diagnosis in both cases was 'primary operable carcinoma of the breast.

Race The distribution of these patients according to racial origin is not particularly significant. There were 27 Americans 14 Irish, 7 Hebrews 6 Russians 5 Negroes 3 Germans 2 Italians 2 Newfoundlanders 2 Polish 1 Norwegian 1 Swede 1 Swiss 1 Hungarian and 1 Turkish patient. The complexion of 24 of these patients was recorded of which 95 per cent were brunettes. Sweat gland cancers of the breast occur more frequently in women whose skins are oily and contain large pores, so we would expect a predominance in brunettes because of their coarser skin textures.

History of lactation Data concerning lactation was available for 67 patients of whom 60 per cent had nursed one or more children of the 16 non-lactating breasts 40 per cent were in single women. Seven patients (12 per

cent) stated that the cancerous breast had been non functional due either to abscess formation causing insufficient secretion or to the fact that it was more convenient to nurse the baby on the other breast. Sixteen patients (20 per cent) had experienced one or more interrupted pregnancies. One woman had 4 full term pregnancies and 11 miscarriages. No conclusion can be drawn from this study concerning the influence of lactation in the production of sweat gland carcinoma.

Trauma Twenty two patients gave a definite history of trauma to the affected breast while 45 others asserted that they could recall no injury to their breasts. The character of the trauma varied however 15 women or 68 per cent of those with breast injuries, stated that a single blow was considered by them to be the cause of the cancer. One patient had sustained the trauma 12 years prior to the detection of the tumor and 3 had discovered a tumor very shortly after the date of injury. The average time elapsing between the trauma and the recognition of the cancer was 2 years. We do not ascribe any etiological importance to the history of trauma recited by these patients for 2 reasons the interval of time was usually too great and the presence of pre-existing tumors could not be ruled out in the 3 instances in which tumors appeared suddenly after injury. In our experience a single trauma has never caused cancer of the breast. We, therefore, believe these histories of single trauma to be of little or no significance. Two women attributed their cancers to chronic irritation by sharp corset steels this condition was not unusual several years ago when high ribbed corsets were in vogue as sweat gland cancers of the breast are frequently situated in the mammary fold. Although but a woman gave histories of chronic irritation from ill fitting corsets impinging on the lower margin of the breast, we believe this type of chronic irritation may not infrequently serve as an exciting cause of sweat gland carcinoma in the lower breast segment.

First symptom In 77 cases the history contained a definite statement concerning the first symptom observed by the patient. Fifty seven patients (76 per cent) gave the discovery of a lump in the breast as their first

symptom and this parallels our experience in a survey of the first symptom in 1 000 cases of mammary carcinoma in general. Fifteen of these patients had inoperable cancers at the time of diagnosis. In 10 per cent of the cases, a discharge from the nipple preceded the discovery of the tumor as compared with 1.5 per cent in the survey previously mentioned. Eight per cent noticed pain as the first evidence of disease either in the affected breast or in the arm and shoulder of the same side which is the identical figure in the 1 000 breast cancer surveys including all types. The 6 per cent remaining had miscellaneous first symptoms such as an increase in the size of the breast, ulceration of the mammary skin, tumefaction of the nipple, or bulky axillary lymph nodes.

Size of tumor. Six of the primary operable carcinomata (14 per cent) were greater than 6 centimeters, 25 (57 per cent) were 3 to 6 centimeters in diameter and 13 (29 per cent) were less than 3 centimeters in size. Of the primary inoperable carcinomata 6 were greater than 6 centimeters in diameter, 8 measured 3 to 6 centimeters and only 2 tumors were smaller than 3 centimeters in size. The operability of any particular sweat gland cancer was never determined by the measurements of the primary tumor but we are recording them to afford complete clinical data.

Location. Dependable data concerning the location of the tumor is available in 74 cases of this series. The accompanying diagram (Fig. 15) shows the regional tumor sites in these patients. In one-sixth of all the cases the growth occurred in the central segment immediately beneath the areola. Eleven per cent of the sweat gland cancers were located in the axillary tail of the breast, 33 per cent in the upper outer quadrant and 10 per cent in the submammary fold. This division is somewhat arbitrary as many tumors which are really located in the axillary extension of the breast spoken of in this paper as the "tail" are recorded to be in the upper outer quadrant. It seems significant that slightly more than half of these tumors are situated in the upper outer quadrant and margins of the breast, which regions contain numerous large apocrine sweat glands.

Rate of growth. Prior to this study it was believed at the Memorial Hospital that sweat gland cancers of the breast were relatively less malignant than some of the other histological varieties but this opinion was not confirmed by our analysis of the cases. For example, 50 per cent of these cancers grew with great rapidity and the 2 oldest patients, aged 84 and 82 years, had rapidly growing tumors. The rate of growth in 31 per cent of the cases was moderately rapid. The youngest patient, aged 19 years, had a slow growing tumor as did 19 per cent of the entire group. Contrary to our observations on mammary cancers in general the sweat gland carcinomata of the breast are apparently not of more rapid growth in young subjects.

Pain. Sensory disturbances varying from slight mastalgia to severe pain in the breast, often radiating to the shoulder and arm, were noted by 28 patients (34 per cent). Sixteen of these patients (or one-third of the primary operable groups) experienced pain before treatment was given. Similar sensory disturbances were found in 9 patients (48 per cent) with primary inoperable breast cancers of this type. In the general group of breast cancers studied at the Memorial Hospital, pain has never been a frequent symptom, occurring in only 8 per cent of primary operable cancers. We attribute the unusual frequency of pain in sweat gland cancers of the breast to early skin attachment and ulceration.

Skin adherence and nipple retraction. Thirty-three (71 per cent) of the primary operable sweat gland cancers of the breast were adherent to skin. The cause of this early and frequent skin attachment probably lies in the superficial location of these tumors. The nipple was retracted or fixed in only 50 per cent of the cases, due to the fact that so many of these tumors were situated at the margins of the breast where they could not exert traction on the nipple. Six of the nipples in patients with tumors centrally located were deeply ulcerated.

Metastasis to lymph nodes. Thirty-two (64 per cent) of the patients with primary operable sweat gland cancers had metastases (proved histologically) in the axillary lymph nodes.

The primary tumor was situated in 40 per cent of these cases in the upper outer quadrant of the breast or the axillary tail. Ten patients (33 per cent) with primary inoperable sweat gland cancers had axillary metastases but not supraclavicular. In 6 other inoperable cases (12 per cent) both axillary and supraclavicular lymph nodes were involved. Fifty-eight per cent of the patients with recurrent sweat gland cancers of the breast had metastases in the supraclavicular lymph nodes which is the usual experience with mammary carcinomata in general.

Metastasis to lungs and pleura. Thirty-seven per cent of these women with inoperable sweat gland cancers of the breast and 25 per cent of those with recurrent lesions had pulmonary metastases demonstrable on roentgenograms.

Metastasis to bone. Only 7 patients (8 per cent) presented definite evidence of metastasis to bone. One young woman under 40 years of age had pre-operative X-ray therapy, local excision of the tumor, interstitial irradiation by platinum filtered radon needles and post-operative X-ray irradiation for an operable sweat gland cancer; she developed pulmonary and bone metastases 1 year later. The rapid extension of the disease to osseous structures parallels our experience with many young women similarly treated for other forms of mammary cancer. Another young patient came to the Memorial Hospital with widespread skeletal involvement but no local recurrence 4 years after a radical mastectomy had been done. Another woman aged 48 years with a slowly growing operable carcinoma and axillary metastases developed bony metastases and died only 6 months after a radical mastectomy. An aged woman of 84 years had a rapidly growing sweat gland cancer which originated beneath the nipple and early became ulcerated. She had metastases to bone at the time of admission in spite of which she lived 4 years after local excision of the tumor and external irradiation with X-rays and radium element pack.

End-results. Of the 50 patients with sweat gland cancers of the breast, classified as 'primary operable' 21 are dead, 20 are living and 9 have been lost to our observation.

The 9 who have been lost to observation, either returned to a foreign country or moved to a distant state. One was known to be well for 6½ years, and another for 5 years after treatment. Of those who died, the average length of life from onset of symptoms to death was 3½ years and the average length of life after the institution of treatment was 3½ years. Five patients lived less than a year after therapy was started, the shortest time being 2 months. Thirty-six of the patients having primary operable sweat gland cancers of the breast were treated prior to January 1927. In this group 5 have been lost to further observation and 16 (44 per cent) are alive and well 5 years or more after treatment. Twenty of these patients were treated prior to January 1925 and 8 or 40 per cent are living and well 7 years after treatment. Seven patients with primary operable cancers of this type were treated before January 1920 (13 years ago) and 2 of these (28.5 per cent) are living, apparently cured of the disease at this time. These percentage figures are slightly higher than the end result percentages recently computed at the Memorial Hospital for primary operable mammary cancers of all histological types viz. 5 year survival without evidence of disease in 217 patients treated by radical mastectomy with pre-operative and postoperative irradiation 41 per cent 7 years, 35 per cent 10 years, 22 per cent. We may conclude from these comparative statistics that the degree of malignancy and prognosis following treatment is practically the same for sweat gland cancers of the breast as it is for the general group of mammary cancers. If a large group of sweat gland carcinomata of the breast could be surveyed with respect to end results, the comparison would be more significant.

In the primary inoperable group consisting of 19 patients, 14 are dead, 4 are living and 1 has been lost to observation. One of the patients who died went into shock immediately after a palliative operation and lived less than 48 hours. The average duration of life after the onset of the disease was 3½ years. 2 other patients in this series stated that a lump was felt in the breast 20 years before admission to the Memorial Hospital. The average duration

of life after the initiation of therapy in these inoperable cases was 21 months, the longest being 5 years and the shortest 4 months. Our 4 patients who are now alive were first treated 9 years, 2 years, 19 months, and 8 months ago. The one who has lived 9 years without a recurrence was 57 years old when first seen in November, 1922. She had a bulky fungating sweat gland cancer with ulceration of the nipple and metastasis to axillary lymph nodes. A roentgenogram of the chest was reported to have shadows suggestive of carcinomatous metastases, however there has been no change in this picture to date. She was treated by radical mastectomy following a pre-operative X ray cycle.

There have been 12 patients with recurrent sweat gland cancers of the breast, 6 are dead and 6 are living. The average time from the onset of the primary disease until death was $4\frac{1}{4}$ years and the average length of life after treatment of the recurrent lesion at the Memorial Hospital was 10 months. The time elapsing between the operative treatment of the primary tumor and the application at Memorial Hospital because of a recurrence averaged 18 months for the 12 patients, the shortest being 18 days and the longest 4 years.

SUMMARY

The human breast develops as a modified apocrine sweat gland. Apparent sweat gland tubules and cysts occur in the normal adult breast where they anastomose with the interlobular lacteal ducts. The characteristic features which distinguish the mammary sweat gland tubules from the lacteal ducts are: constant eosinophilia of the cytoplasm, an inner layer of high columnar cells, the occasional presence of myo-epithelial cells surrounding the tubules and the tendency to form intratubular and intracystic papillary tufts. The anatomical and staining characteristics of these cells persist through all the transitional phases of normal sweat gland tubules, cysts, intracystic papillomas, adenomas, and carcinomas.

Evidence is presented to substantiate the theory that sweat gland carcinomata of the breast may develop from pre-existing sweat gland tubules, cysts, and papillary adenomata.

The various stages in this transition have been seen. Except for the peculiar properties of sweat gland structures in the breast which we have enumerated, the sweat gland carcinomata of the breast have much the same structure as other mammary cancers, e.g., we find that the bulky adenocarcinomata, the comedocarcinomata, the papillary intraductal, and intracystic carcinomata, the medullary carcinomata, the carcinoma simplex, and even scirrhous carcinomata of the breast are represented in this group.

Sweat gland cancers of the breast occur more frequently in swarthy brunettes whose skin has large pores and oily, coarse texture. Their regional distribution is mostly on the periphery of the breast, particularly in the axillary tail and submammary fold. The frequency of pain, skin adherence, and ulceration are significant clinical features of sweat gland cancer of the breast. The degree of malignancy and the prognosis following treatment is practically the same for sweat gland cancers of the breast as it is for the general group of mammary cancers.

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PEPTIC ULCERS ARTIFICIALLY PRODUCED IN THE HUMAN BEING

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CLINICAL and experimental observation has now made it evident that the presence of the gastric juice is an important factor in the production of gastric ulcers. If the juice is allowed to act upon the mucosa of the duodenum ileum or jejunum in an undiluted state an ulcer almost invariably develops. Such a condition may be seen around the islands of gastric mucosa occasionally found in a Meckel's diverticulum or in a gastric pouch experimentally made and united with the intestines (1).

The fact that the gastric juice does not invariably lead to ulceration of the normal stomach or of the jejunum after gastro-enterostomy has been the subject of prolonged investigation. One of the factors of importance is believed to be the dilution of the gastric juice which usually occurs in the stomach. Removal of the salivary glands (3) or the formation of an œsophagostomy opening through which all the saliva escapes is not invariably followed by ulceration nor does such regularly occur in patients with a complete œsophageal obstruction.

Matthews and Dragstedt also failed to produce ulceration in dogs after the performance of a gastrostomy and an œsophageal fistula whereby sham feeding was carried out and the secretion of acid was induced without being diluted by the food which escaped through the fistula. If however, the alkaline secretion of the bile and pancreatic juice was removed, ulceration occurred in a high percentage of cases. Removal of these alkaline secretions was easily accomplished by excising the pylorus closing the duodenal stump, dividing the jejunum just below the duodenojejunal flexure anastomosing the cut end of the stomach with the distal end of the jejunum and the proximal end of the jejunum into the ileum close to the ileocaecal valve. Similar operations and results were performed by Mann (1).

These experiments were to a certain extent vitiated by the fact that the animal developed

a cachexia and then died probably owing to the effect of transposing two such important digestive secretions so low down in the ileum. When bile and pancreatic fluid were allowed to enter the intestines higher up ulceration was less common. Matthews and Dragstedt have shown that this is probably due to regurgitation of the alkaline secretions for if regurgitation was prevented by an ingenious method they devised the ulceration became more common.

The artificial formation of a pancreatic fistula which can be performed upon an animal kept alive by daily injections of salt solution is also followed by chronic ulceration. The important factor therefore in preventing the gastric juice producing an ulcer in a normal animal is the neutralizing effect of the pancreatic juice and bile.

The effect of such factors are much more difficult to determine in the human being. Although gastro-enterostomy is usually performed for chronic ulceration in which the acid is usually high gastrojejunal ulceration does not in the hands of most surgeons, occur more frequently than in 3 per cent of the cases. In my own series of 1247 gastro-enterostomies, such ulceration occurred in 25 that is 2 per cent. Moreover, after an adequately performed partial gastrectomy, my own experience agrees with that of Lord Moynihan that such ulceration is practically unknown. In my own series of 466 partial gastrectomies it occurred in only one case in which it was known that gastric resection was insufficient.

In the human being the conditions experimentally produced in animals rarely occur but it is interesting to note that the Roux operation of partial gastrectomy which most closely produced these conditions, in that the pancreatic juices entered the jejunum well below the end to-side anastomosis, has now been universally abandoned as it was followed by so high a percentage of gastrojejunal ulceration. In the 2 following cases the

conditions experimentally produced in animals were somewhat closely simulated and the resulting formation of chronic ulceration becomes of considerable clinical interest.

CASE I: Development of peptic ulcer after partial pancreatectomy and partial gastrectomy

A.E.L. male aged 38 years, had suffered with attacks of epigastric pain from 1906 until 1913. The attacks would last for about 3 months and for 1 year they had been getting longer. The pain came on shortly after food, was severe in nature and often indeed agonizing. It was associated with vomiting which gave some relief to the pain. On June 23, 1913, he was operated upon by another surgeon who found what he thought to be a large carcinomatous ulcer in the middle of the stomach. In performing a partial gastrectomy the surgeon realized that the neck of the pancreas had been cut through and practically the whole of the body removed with the ulcer. Pathological investigation showed that the ulcer was benign. This operation was apparently followed by the formation of a subphrenic abscess which was drained and the patient then steadily improved and put on weight. In 1916 however his symptoms began to return. He then had attacks of radiating pain through the epigastrium to the lower abdomen. The pain occurred relatively late after food and was relieved by food. It was associated with vomiting which also gave considerable relief. In June, 1921, he was admitted to Hospital and his test meal showed free hydrochloric acid 15 per cent and a total acidity of 53. An X-ray investigation was performed and was said to be suggestive of a jejunal ulcer. He was treated by dieting. In September 1922, he sought my advice as his symptoms had been getting worse. The pain would now wake him at night and the last attack had persisted for 6 weeks. His appetite had been getting poor and he had been losing weight. On examination there was some tenderness in the epigastrium but no definite tumour. His hydrochloric acid was now 12 per cent and his total acidity 45. The X-ray examination showed a constant meniscus in the region of the gastrojejunal opening. An operation was performed on September 20, 1922 and a gastrectomy of the Billroth II type was found. In the center of the anastomosis was a very large indurated ulcer. Practically no pancreatic tissue could be found. A more extensive partial gastrectomy was performed, only about half an inch of the lesser curvature being left. The excision was planned not only to remove a large portion of the stomach but also the loop of the jejunum attached to it. An anastomosis was carried out between the cut end of the stomach and the two cut ends of the jejunum by the Polya method, the afferent loop being brought to the lesser curvature and the efferent to the greater curvature. The pathological report stated that there was a chronic progressive peptic ulcer in the jejunum and very numerous oxyntic cells in the gastric mucous

membrane. The patient made an uninterrupted recovery and has been seen at frequent intervals in my follow-up department since. He is now quite free of symptoms, is taking all food and is able to live a perfectly normal life.

CASE 2: Development of peptic ulcer after cholecystenterostomy for pancreatitis

J.G. male aged 52 years, was first seen on July 9, 1929. For 4 months he had noticed that he was becoming jaundiced and had had some shivering attacks. For some 3 months there had been itching of the skin of the whole body which was relieved only by soda baths. His appetite had remained good, and there had been no pain of any sort. In spite of a careful diet and medical treatment his jaundice had been progressing. He had lost a stone in weight in the last few months. On examination he was found to be a thin jaundiced, restless man. The liver could be felt uniformly and smoothly enlarged. There was no tenderness. The gall bladder could not be felt. The stools were clay colored. An operation was performed on July 12. The pancreas was found to be uniformly hard and enlarged, and there were no localized nodules. The head and body presented a similar consistency. The gall bladder was distended and tense but tucked away under the enlarged liver. There was no evidence of any secondary growths and no stone or growth could be felt in the common bile duct. The stomach was smooth and the duodenum was tied down in the right lumbar region. It was found that the gall bladder could only be approximated to the duodenum or stomach with some difficulty and it was, therefore, thought wiser to bring a loop of small intestine about 18 inches from the duodenojejunal flexure up through the mesocolon. The gall bladder was emptied, and thick, tenacious bile was removed and an anastomosis was then performed between it and the loop of the small intestine. The patient made very good progress and his jaundice rapidly decreased. Three months later he was feeling very well. On January 24, 1930, he complained of having had indigestion for 2 weeks and on March 18, he was found to be very anemic and complained of epigastric pain passing to the back. This was severe and occurred late after food. He was admitted to hospital and the stools were found to be very black and contained a large amount of blood. There was a considerable degree of anemia. The test meal showed free hydrochloric acid 16 per cent and a total acidity of 75. An X-ray investigation showed a clear lesser curvature of the stomach and no delay at the pylorus. It was interesting to find that the gall bladder filled rapidly and easily with the barium meal and presented a picture of a big duodenal pouch. There was no evidence of a chronic duodenal ulcer. The patient was kept in bed and treated medically and improved very considerably and in April, 1930, was free from symptoms and his anemia had recovered. In spite of the alkaline treatment, he had another attack of melena in January 1931 and became very anemic. He was seen by a physician and kept in bed on a

strict diet and made some improvement but in August 1931 it was again noted that he had blood in the stools. On September 15 he was readmitted to hospital complaining of a considerable amount of pain and tenderness, a blood examination showed only two and a half million red blood corpuscles. On September 18 1931 a second operation was performed. Dense adhesions were found around the gall bladder and anastomosis and behind this could be felt a hard indurated area in the first part of the duodenum. The pancreas was smooth and very hard. It was thought that the duodenal ulcer was unquestionably due to removal of the alkaline juices, which were probably diminished by the presence of the pancreatitis, from the duodenum to the jejunum. The efferent loop from the cholecyst enterostomy was therefore freed and brought up to the stomach, an anterior gastro-enterostomy being performed. The patient stood the operation very well and made an uninterrupted recovery. His pain disappeared the blood count rapidly improved and he ceased to pass blood in the stools. He has been seen from time to time in the follow up department and the last note September 1932 states that he is very well is on a full diet with no pain the anaemia has completely disappeared and he is living a normal life.

In the first of these cases the pancreatic secretion was greatly diminished by the extensive pancreatectomy and thus failed to neutralize the gastric juice, although this was reduced by the partial gastrectomy. In the second case the pancreatic secretion was not only probably in part reduced by the pancreatitis but was made to enter the intestine at a considerable distance from the duodenum so that the gastric juice was not neutralized. Reduction of this juice in the one case and its adequate neutralization in the other brought about a complete cure.

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OSTEOCHONDRITIS OF THE GROWTH CENTERS

A FURTHER CONSIDERATION¹

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THE purposes of this paper are (1) to present three cases of osteochondritis of the growth centers, (2) to discuss and correlate the clinical and pathological aspects of the disease, (3) to present a method for the investigation of the pathogenesis of this condition and (4) to urge the necessity of prolonged avoidance of weight bearing in certain types of the disease.

Although the literature is rich in case reports and discussions of osteochondritis there has been an almost complete absence of pathological studies. During the past year four unusual cases have been studied and from three of these biopsies were obtained. These cases are presented with the thought that by a continuance of such studies the pathogenesis of osteochondritis may eventually become more clearly understood.

Harbin and Zollinger in 1930 reviewed the pathological changes that occur in the various ossification centers of the human skeleton and called attention to the fact that a wide variety of terms are used to designate the same type of lesion occurring in different places. They proposed to simplify the confused nomenclature that has arisen because of the application of proper names to the disease in the various growth centers, by the use of the term "osteochondritis" in conjunction with the name of the growth center involved. The name of a disease should be descriptive of the pathological changes involved and the term "epiphysitis" was deemed unsatisfactory because the disease is not confined to the epiphysis. It is recognized, too that the term osteochondritis is not entirely descriptive, inasmuch as its inflammatory character is not fully established. The selection of a suitable name must await further pathological studies.

Zemansky in 1928 gave a comprehensive summation of the literature regarding the pathological changes occurring in the capital epiphysis of the femur. Although all of the

cases which he reported had some findings in common they varied in detail. He concluded that the pathological changes occurring in this disease in the hip were extensive subchondral necrosis of bone and marrow with complete destruction of the epiphyseal line fragments of dead bone surrounded by richly vascularized granulation tissue fibrous tissue replacement of necrotic areas with osteoid formation from fibrous tissue and pre-existing bone lamellae dilated blood vessels in the under surface of the cartilage. In the 11 cases which he summarized the epiphyseal line was present in cases of short duration, while in those cases extending over a longer period it was at least partially destroyed. Later Lippmann reported a case focusing his observations principally on those occurring in the round ligament. In this he demonstrated obliterative thickening of the vessels with hemorrhage and edema of the ligament itself. In the case reported by Harbin and Zollinger there were no pathological changes seen in the specimen removed for biopsy. Vignard also reported 2 cases in which no change was observed. It is probable that in these latter cases the biopsy simply failed to include definite diseased areas.

CASE 1. A white girl, aged 4 years, was originally admitted to the Rainbow Hospital with the complaint of stiffness in joints and weakness. She had been a full term, normal infant. Breast feedings were given for the first year with the addition of cod liver oil and orange juice. The first teeth appeared at 7 months, and the remainder were normal in time of appearance. The child talked at 18 months and walked 1 month later. At that time it was noted by the mother that movement in all of the joints was limited, and that when the child walked the feet were turned outward at right angles to the body. In addition, the ankles, knees, wrists, and elbows were larger than normal, and she could walk only a short distance before becoming tired. The family physician said that she was underdeveloped, and he increased the amount of cod liver oil. She was seen later by another physician who made a diagnosis of severe rickets, and she was treated following this with ultraviolet lamp

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Fig. 1



Fig. 2

Fig. 1 Enlargement of the malleoli, knees, and wrist in Case 1

Fig. 2 There is marked irregularity and narrowing of the vertebral nuclei (Case 1)

Fig. 3 Changes seen in the lumbar spine are similar to those present in the dorsal segments (Case 1)



Fig. 3

and given viosterol. She had always been subject to frequent colds and was underweight. It was noted by the parents that she frequently perspired about the forehead. The mother felt that she had shown little if any general improvement and that in addition she was becoming more round shouldered. There had been no gastro-intestinal upsets and the bowels were always regular.



Fig. 4 Beside the changes characteristic of osteochondritis in the hip the pelvic girdle presents an abnormal degree of density (Case 1)

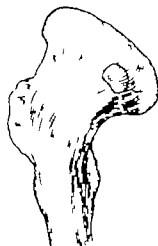


Fig. 5 Schematic illustration showing area from which tissue for biopsy was taken (Case 1)



Fig. 6 Non-ossified epiphysis of femur comprised of hyaline cartilage which is the seat of fibillar degeneration and extensive vascularization. $\times 70$

The 4 other children in the family were in excellent health. Parents were small in stature.

The physical examination revealed an underdeveloped and somewhat undernourished child with a generalized muscular weakness who was unable to stand without support or to walk for more than a short distance unaided (Fig. 1). The knees were flexed slightly when she walked. The head, eyes, ears, nose and throat were normal. The teeth were normal and the tonsils were not enlarged. The heart and lungs were normal, and there was no gross evidence of rickets in the bony thorax. The spleen and liver were not palpable. The extremities showed weakness and atrophy that was most marked in the legs. The thenar and hypothenar eminences of both hands were flattened. The proximal interphalangeal joints of the third and fourth fingers of both hands were enlarged and fusiform in shape. The wrists were large and broad. There was no muscular atrophy of the arms or forearms, and movement in all the joints, except the right wrist, was within normal range. The right wrist showed marked spasm and limitation especially on hyperextension. The internal malleoli of both ankles were enlarged with thickening about the joints. The knees were enlarged with periarthritic thickening but they were not tender. The left hip showed normal flexion with 5 degrees of adduction and 15 degrees of abduction. There was 5 degrees of internal rotation and 35 degrees of external rotation. The right hip showed unlimited flexion with 45 degrees of motion in both abduction and adduction. Internal rotation was limited to 10 degrees with 45 degrees external. Motion was painless. The usual reflexes were present and equally active. The spine showed a moderate dorsal kyphosis with rounded shoulders.



Fig. 7 Articular cartilage showing active vascularization with formation of trabeculae of osteoid. Zone of proliferate cartilage is not unusual and the zone of provisional calcification is not apparent. Extensive degeneration, laceration and vascularization of cartilage. $\times 300$.

Roentgenograms showed the dorsal and lumbar vertebrae to be irregular in outline mainly in their anterior portions (Figs. 2 and 3). The intervertebral spaces were maintained throughout but the bodies were flattened. The capital epiphyses of both femora were flattened and irregular (Fig. 4). This was most marked on the left where there was fragmentation and some evidence of migration of the head toward the trochanter. The necks were very short and greatly thickened but the epiphyseal lines could be seen. A similar process was seen in the heads of both humeri, the condyles of the femora and the patella. These changes were also seen but to a less extent in the ankles, wrists, and the metacarpals.

Laboratory examination showed no abnormalities of the urine or blood. The blood Wassermann was negative. The basal metabolic rate was increased 21 per cent. The blood serum calcium was 10.6 milligrams per 100 cubic centimeters and the phosphorus was 4.5 milligrams.

The patient was placed in the dorsal decubitus position on a hyperextended Bradford frame because of the dorsal kyphosis. Free use of the extremities was encouraged by physiotherapy including exercises in the underwater gymnasium. A fairly constant range of temperature from 37.5° C. to 38° C. (rectal) was observed. She showed slight general improvement, and, on December 9, 1931, an exploration of the left hip was carried out through an anterior incision.

At operation the capsule was found to be normal. The head was definitely enlarged and the neck was short and thick but there were no other gross abnormalities. The acetabulum was normal in appearance. Tissue for biopsy was removed from the region of the epiphyseal line including the adjacent tissue (Fig. 5). The tissue was softened but well vascularized.



Fig. 8. Early change in the right hip. There is only slight flattening of the head and shortening of the neck (Case 2)

Motion was restricted only by a crinolin spica and convalescence was uneventful without febrile reaction. Aerobic and anaerobic cultures were negative.

The specimen submitted for pathological examination consisted of a cylinder taken from the head of the femur so as to include the entire thickness of the articular cartilage, the bony epiphysis, and the epiphyseal plate of cartilage. The bony changes were not remarkable and appeared to be secondary rather than primary. In spite of the marked deformity of the head of the bone seen roentgenologically, the general pattern and structure of the trabeculae were normal. The density varied with osteoporosis predominating. The marrow was not unusual except in the subchondral zone where it was fibrous. There was no necrosis and no hemorrhage. The articular and epiphyseal chondro-osseous junctions were very irregular. The primary spongiosa in both situations was poorly calcified and preponderantly of osteoid. The zone of provisional



Fig. 9. Presents a marked degree of progression of the disease in the capital epiphysis on the right with fragmentation of the head (Case 2)

calcification was irregular and poorly defined. Enchondral vascularization was very pronounced and the penetrating blood vessels were found at greater distances from the marrow than usual. These vessels were surrounded by collars of osteoid and frequently by wide zones of proliferating fibroblasts. Despite the vascularization the enchondral ossification was focal and generally retarded. This retardation seemed best accounted for by the severe degenerative changes present in the cartilage. Foci of degeneration and necrosis were scattered throughout the epiphyseal and articular cartilage and in the latter there were deep fissures and tears, sometimes reaching the chondro-osseous junction (Fig. 6). Areas of resting cartilage were interposed between areas of cartilaginous hyperplasia and the hyperplastic foci were almost invariably associated



Fig. 10. Diagram indicating the point of removal of tissue for biopsy (Case 2)



Fig. 11. Articular cartilage, Case 2 including a group of ingrowing marrow vessels at the edge of an area of cartilaginous degeneration. There has been focal absorption of the matrix which has taken on a fibrillar character. Such areas are especially well vascularized but without ossification. $\times 65$



Fig. 12. Presents very slight change in the right hip. The head is slightly flattened. (Case 3.)

with disintegration of the matrix. Much of the vascularization with accompanying fibroblastic proliferation appeared to be in the nature of a repair process, when there had been dissolution of the original hyaline cartilage (Fig. 7).

Since the foregoing procedure was carried out, the patient has been given general hygienic treatment including ultraviolet lamp therapy and cod liver oil. Her posture has improved slightly but her general condition shows but little change.

CASE 2. A white boy of 8 years was admitted to Lakeside Hospital in January 1931 with the complaint of pain in the right hip and a limp of 2 months duration. There was an indefinite history of a fall at the beginning of the illness. Examination at that time showed a few carious teeth and enlarged tonsils. The extremities were normal except for the right hip. There was flattening of the buttock and 1 inch atrophy of the thigh. Palpation revealed no peri-articular thickening or tenderness. Motion was limited in abduction and internal rotation. Roentgenograms of the hip showed some flattening of the capital epiphysis with definite increased density in a portion of it (Fig. 8). Urine and blood studies were normal. The blood Wassermann reaction was negative, and the tuberculin test, 1:1000, was negative. The patient remained in bed but showed no clinical improvement in the hip, and a plaster spica was applied on February 18, 1931. This was removed after 6 months, but after he was allowed up a limp was immediately noted. He denied any pain, and the roentgenogram showed only a slight increase in density of the epiphysis.

In February 1932 he was readmitted to the hospital with the complaint of a dull aching pain in the right hip which always appeared after walking

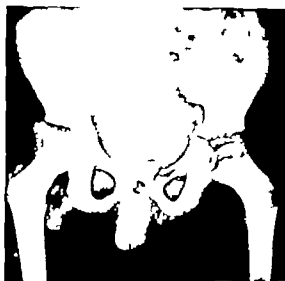


Fig. 13. Shows rapid progression of the disease with irregularity and fragmentation of the head but no appreciable thickening of the neck. The epiphyseal line is irregular. (Case 5.)

or playing for a short time. Examination revealed the right leg to be 0.5 inch shorter than the left. The right buttock was flat, and there was 2 inches atrophy of the thigh. Motion at the hip showed abduction of 25 degrees, flexion of 25 degrees, internal rotation of 5 degrees, and external rotation of 10 degrees. There was no palpable tenderness or thickening. Roentgenograms showed progressive flattening and fragmentation of the capital epiphysis on the right (Fig. 9). The blood Wassermann reaction was negative, and the tuberculin test, 1:1000, was negative. The serum calcium was 11.2 milligrams per 100 cubic centimeters of blood and the serum phosphorus was 4.9.

On February 16, 1932 an exploration of the right hip was carried out through an anterior incision. The synovia was thickened and hyperemic. There was increased fluid in the joint. The head of the femur was large and smooth and capped over a shortened neck. Across the top of the head was a groove that corresponded to the position of the upper margin of the acetabulum as it rested against the large head. The acetabulum was of normal size and depth but too small for the head. There was no evidence of a round ligament. The epiphyseal line was identified and two blocks of tissue were removed from the epiphysis with an osteotome (Fig. 10). Aerobic and anaerobic cultures were taken from the joint and the depths of the wound from which the tissue was removed.

The gross specimen showed what appeared to be islands of cartilage in bone tissue. Microscopically there was marginal thickening of the articular cartilage. Scattered through the cartilage were

degenerative foci ranging from fibrillation to necrosis. In the fibrillary areas around the small blood vessels the matrix was absorbed and the vessels were surrounded by actively proliferating fibroblasts to produce small cellular islands (Fig 11). The chondro-osseous junction was quite irregular and the bony lamella thin and interrupted. The most conspicuous change seen was simple rarefaction of the matrix, and in some instances this was associated with the granular deposition of calcium. Independent islands of bone with fatty marrow were seen in the cartilage. The synovia was thrown into polypoid folds and the lining cells were hyperplastic. Beneath the surface the synovia was richly vascularized and there was considerable lymphocytic infiltration that was characteristically perivascular. *Staphylococcus albus* grew in aerobic and anaerobic cultures.

Convalescence was uneventful and the patient's condition has remained about the same. Roentgenograms show a slight increase in the amount of fragmentation. He has been given cod liver oil and ultraviolet lamp therapy as a general measure and has not been allowed to bear weight on the involved extremity.

CASE 3. A white boy, aged 4 years, was first admitted to Rainbow Hospital August 1931, because of a painful right hip. The onset of the complaint had occurred very suddenly in June 1931, when he first complained of pain. Soon after this a limp was noted by the members of his family. This lasted for about 1 week and then disappeared; however, it recurred about 10 days later and was so severe that he could not walk. Roentgenograms showed very slight flattening of the capital epiphysis on the right (Fig. 12). He was placed on a Bradford frame with the leg in traction. By November 18, 1931, all physical signs had disappeared, and he was allowed to go home. He returned 1 month later with reappearance of all symptoms with increased severity and in addition a history of *night cries*. His past history revealed only an attack of mumps, frequent colds, and sore throats.

The physical examination showed a moderately well developed but somewhat undernourished white boy. The examination was essentially normal except for the right lower extremity. There was no shortening of the right leg but there was 1 inch atrophy of the thigh. Palpation revealed no tenderness, but there was marked spasm with any attempt at motion. Internal rotation and hyperextension were completely limited and abduction was limited to 10 degrees. Roentgenograms showed definite flattening of the capital epiphysis with some fragmentation (Fig. 13). The neck was hairy and irregular with two small punched out areas in the diaphyseal side of the epiphyseal line. The urine was normal. The Wassermann test was negative. Tuberculin test, 1:1000, was negative. The serum calcium was 10.4 milligrams per 100 cubic centimeters of blood and the serum phosphorus was 4.7 milligrams.



Fig. 14. Diagram showing the points of removal of the tissue for biopsy (Case 3)

Following admission he was placed in traction and the pain and spasm grew less. On January 30, 1932, because of the unusual appearance the hip was explored through an anterior incision. It was our impression before operation that we were dealing with an osteitis rather than an osteochondritis. The capsule was found to be thickened and hyperemic with some increase in fluid. The head and neck showed no gross abnormalities and the acetabulum appeared normal. A block of tissue was removed from the epiphyseal line with an osteotome (Fig. 14). The tissue did not appear to be as well vascularized as normally and the material was softer than usual. Microscopic study showed foci of degeneration in the cartilage which were in places myxomatous and in others fibrillar. Such degenerate foci were sharply circumscribed (Fig. 15) and occasionally associated with vascularization and beginning calcification. There was a moderately severe osteoporosis. Cultures showed no growth.

Convalescence was uneventful and the patient was again placed in traction. Gradually all spasm and limitations have disappeared and at present there is no limitation of motion. He has not been allowed to bear weight on the extremity for almost 5 months, however. Recent roentgenograms show some slight fragmentation of the epiphysis.

The fourth case is presented to show the striking similarity of arthropathy of the tarsal scaphoid to osteochondritis.

CASE 4. A white boy, aged 12 years, was admitted to the hospital with the complaint of swelling of the feet. At the age of 3 the patient had an attack of diphtheria and some time following this the mother noticed that his legs were weak and that it was more difficult for him to walk than it had been previously. This condition remained about the same until he



Fig. 15. Epiphyseal plate showing normal hyaline cartilage at the top separated from the degenerate cartilage at the bottom by an area of cartilaginous regeneration and proliferation. Such spontaneous repair was not a prominent feature, the degenerate areas usually being vascularized and collapsed. $\times 81$.

was 10 when it was noted that he was walking on his toes with the feet turned in. In August 1931 the patient noticed, while running barefoot, that the right foot was swollen and a little tender. The swelling persisted up until the time of admission to the hospital, without pain. There was no history of injury, chills or fever or of polymyositis. His general health had always been good.

The mother and father were cousins. There were four children in the family. The oldest had had no difficulty. The next oldest boy had been in the hospital repeatedly with a complaint somewhat similar to that of this patient. In addition he has shown marked loss of sensation with trophic disturbances in the lower extremities. The youngest child, a girl, is normal except for a cardiac lesion thought to be rheumatic in origin.

The physical examination showed a fairly well developed, somewhat undernourished, white boy whose examination was not remarkable except for the lower extremities. The legs showed atrophy with complete relaxation of the longitudinal arches in both feet. The tendo achillis on each side was tight and prevented dorsiflexion of the foot even up to a right angle. The legs were equal in length and the muscle power below the knees was very poor except for the gastrocnemii. He was unable to invert the foot at all and the peroneals were only



Fig. 16. The right foot in the lateral position shows compression and fragmentation of the scaphoid. A lateral film of the left foot illustrates the same character of change in the head of the astragalus. (Case 4)

moderately strong. There was swelling with peri-articular thickening over the dorsum of both feet, most marked over the right in the region of the scaphoid where there was local heat and redness, but there was no pain or tenderness in either foot. When he walked he rose on his toes with the knees flexed. The toes and knees were pointed inward to maintain balance. He walked with a peculiar shuffling scissors-like gait as he lurches from side to side and swung the arms to keep from falling. The reflexes in the arms, abdominals, epigastrics, and cremasterics were normal. In the lower extremities the reflexes were hyperactive with both patellar and ankle clonus. The latter was a constantly sustained response, the former only occasionally. There was a Babinski response to plantar stimulation on both sides and the Romberg test was positive. The cranial nerves showed no involvement and the eye-grounds were normal. There was weakness of the lower abdominal muscles. There was no change in sensation over any portion of the body and the joint sense was normal. There was no ataxia, no intention tremor, no past pointing. Speech was difficult. The vibratory sense was not lost.

Roentgenograms of the feet (Fig. 16) showed a destructive process involving the right scaphoid and the anterior portion of the astragalus. On the left the astragalus alone was involved. The bony arches were flattened. The spine showed no abnormality.

Laboratory studies showed the urine and blood to be normal. The Wassermann reaction was negative. The tuberculin test, 1:1000 was negative. The serum phosphorus was 4.3 milligrams per 100 cubic centimeters of blood and the serum calcium was 10.3 milligrams. The spinal fluid was clear and colorless. The Pandy test was negative and there were no cells. The Wassermann test was also negative.

The patient was kept in bed over a period of weeks until the redness and swelling had disappeared.

Since he has been allowed to walk his condition has changed very little except that under training his gait has somewhat improved. We believe this to be a case of *hereditary family spastic paraplegia* with changes in the bones of the feet resembling osteochondritis but probably an arthropathy.

The first patient presented several rather perplexing problems. She was the first patient that we have seen or of whom we have heard in whom the condition was generalized. When first seen she had the appearance of having polyarthrits with enlargement and stiffness of all the joints. The involvement of all the epiphyses and particularly the appearance of the hands suggested achondroplasia but there was no disparity in comparison between the length of the torso and the extremities. The normal blood serum calcium and phosphorus, absence of certain stigmata and the roentgenographical appearance helped to rule out rickets.

Harbin and Zollinger reported one family in which four individuals showed osteochondritis of the spine. Such observations together with this case cause one to consider again both hereditary and metabolic factors in the etiology in these individual cases.

The second patient was given the benefit of immobilization over a period as long as that in which many cases have begun to show clinical improvement. It is evident that the process was not healing since with weight bearing the condition progressed and the signs returned once more. The roentgenographical picture was then striking as compared with the earlier one showing only slight flattening and areas of increased density. At operation there was found evidence of inflammatory change in synovia, joint, and bone. Four cultures were taken in all two aerobic and two anaerobic, and all showed *staphylococcus albus*. This is the first positive culture that we have ever obtained from a patient with osteochondritis. It suggests again a consideration of infection as an etiological factor but only in this individual case. The condition, therefore, may be one of osteitis rather than osteochondritis.

The third patient was immediately immobilized with the acute onset. At that time we felt that such a long period of immobilization was not necessary and he was allowed to

run about after the acute signs had disappeared. Within a short time the acute symptoms returned and it is evident from the roentgenograms that the disease had progressed rapidly. It is of interest that the clinical signs and symptoms have again disappeared but he has not been allowed to bear weight at this time.

It would appear that the pathological picture in these cases varies from that described by previous observers in that instead of describing and discussing a different condition we are seeing merely different phases in the pathogenesis of the same condition. Beyond doubt, all of the cases described except possibly Case 2 can be clearly classified as osteochondritis of the capital epiphysis from the appearance of the roentgenograms. We did not remove the entire head in any case as we felt that in such young individuals such treatment is too radical. It is true that in older individuals we see frequently an arthritis of the hip which we ascribe to an old osteochondritis. In such cases excellent results have followed the Whitman reconstruction operation. In growing children however we believe that removal of the head will aid in preventing later arthritis. It will also prevent further growth from this important center and for that reason is not a procedure of choice.

The pathological changes observed in all 3 cases were similar in that the cartilage both articular and epiphyseal was the seat of the most striking alteration. The osteoporosis of the epiphysis could be explained by the inactivity rather than as a feature of the disease. The irregularity in density of the osseous head was thought to be due to the irregular retardation of enchondral ossification and to the production of osteoid rather than bone. The asymmetry and non-development (apparent destruction) of the head seemed better accounted for as a failure in new bone formation rather than as a destruction of already formed bone inasmuch as the former was seen to be true while there was no necrosis or unusual osteoclasia to indicate the latter. This lack of ossification was related to if not caused by a deterioration of cartilage, which was focal and which ranged

from simple fibrillation to necrosis of cells and dissolution of matrix. The cartilage was so severely altered that despite the relative inactivity of these individuals deep fissures and tears through the entire articular plate were observed. The cause of the cartilaginous degeneration was not apparent although faulty nutrition is obviously suggested. Harbin and Moritz called attention to the presence of interlacunar canaliculi in the matrix of hyaline cartilage and suggested the importance of these canaliculi in the dissemination of nutritive substances throughout cartilage. The primary defect responsible for the imperfect ossification of the epiphysis may rest in the lack of permeability of the cartilaginous matrix with subsequent degeneration so as to inhibit proper enchondral ossification. The fact that the cartilage was so richly vascularized does not militate against this hypothesis because the presence of the blood vessels may represent an attempted compensation or may be regarded as a reparative process for the necrosis.

Microscopic evidence of inflammation was not seen either in bone or cartilage. The chronic hyperplastic synovitis observed in one case was not explained.

We must conclude that the necrosis and repair of bone described by Zemansky was either a different phase of the disease than seen by us or a manifestation of greater severity. The latter belief seems more tenable if one accepts the hypothesis of the repaired nutrition to explain the cause of the epiphyseal change. Whereas in the cases seen by us the cartilage was damaged to the extent of being unsuitable for enchondral ossification it is not difficult to consider the same process becoming extended to include the bone and cause the necrosis described by other authors.

In order to complete the pathological picture the entire pathogenesis must be seen and studied. This can be accomplished if com-

plete clinical and laboratory study of all cases is made followed by a biopsy according to the Key block method. It will then be possible to correlate pathological change with the gross and roentgenographical appearance. Large numbers of such cases will eventually result in a varied picture which if viewed with sufficient perspective may allow us to gain a clear conception of the etiology of osteochondritis. We have reason to think that years are necessary for healing to take place in this disease and that alone would seem to account for a great part in the variation of the histopathology.

SUMMARY

1. Three cases of osteochondritis are reported with clinical findings and associated pathological change. One of these cases showed a generalized involvement of growth centers, the first of its kind ever to have been published.

2. An attempt is made to correlate the varied pathological reports from the literature.

3. A method is offered as an aid in obtaining the complete pathology and the etiology is discussed.

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THE RELATION OF MATERNAL METABOLISM TO
INFANT BIRTH WEIGHT

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THE factors which influence intra uterine development of the fetus and its weight at birth remain obscure although the problem has been attacked both in man and in experimental animals from many angles.

The assumption of a relationship between maternal weight and maternal diet during pregnancy to infant birth weight seems so probable that it has been studied exhaustively (1, 4, 5, 6, 7, 8, 13, 17, 22). The results however have been for the most part negative and it is now generally believed that diet plays no rôle of consequence in influencing the birth weight of the newborn. There is experimental evidence to show that healthy well nourished rats produce litters of greater total weight than smaller animals fed on a deficient diet (7, 8) but the variation is so small as to be quite negligible. The opinion of present day investigators may best be summed up in the statement of Franz and Zondek, quoted by Jonen (4): "The fetus develops without consideration of the maternal organism and like a parasite withdraws what it finds necessary to its composition." If the maternal organism does not provide the materials necessary for fetal development damage to or death of the fetus results with subsequent abortion (4, 5, 8, 17, 22) but without noticeable effect on birth weight.

Other maternal factors which have received attention include age (1, 7), social status (15), national disturbances such as war (14), number of previous pregnancies (7, 15, 24), whether or not previous offspring have been suckled (1), length of pregnancy (2, 7, 18), seasonal variations (1, 16, 24), primiparity versus multiparity (9, 15) and the duration of the menses (9, 21). With the exception of the last named such factors bear only an insignificant relationship to birth weight, influencing average infant weights less than 100 grams. The older the mother the greater the birth weight, and the more unfavorable the social status and the greater the national dis-

turbance the more unfavorably fetal development is affected. If previous offspring were suckled birth weights decrease in subsequent pregnancies. In general, infant birth weight is greater in summer than in winter. The birth weight tends to increase with the number of pregnancies.

Matarese, and Szenes and Mondré, listing 400 and 739 human births respectively point out the correlation between length of menstrual period and infant birth weight and show that weight and length of the child at birth are directly proportional to the duration of the menses in days.

The nutrition of the father has been studied in animals (8) but no relationship was observed.

The action of the various vitamins has been investigated in attempts to clarify the problem (8, 12, 16, 17, 22, 23), but the results have been no more convincing than other starvation experiments along the same lines. Depletion of vitamins produces fetal damage (8, 17, 22) and abortion while an increase in vitamin D in the maternal diet influences intra uterine development favorably (12, 22) and is an aid in hindering habitual antepartum fetal death (12).

The placenta has been studied from the standpoint of iron content (3) and of architectonic structure of the blood vessels (20). The iron content of 100 grams of placenta was correlated with birth weight and was found to vary directly with the birth weight in children below normal limits, reaching its highest value in children in the usual range (2,800 to 3,500 grams) and then decreasing in the higher weight groupings. Shordania found that there was a tendency to lower placental and fetal weights if there was great diffusion of the main vessels of the placenta.

PURPOSE OF PRESENT STUDY

The present study was suggested by certain unpublished data indicating sectional differences in average birth weights and was

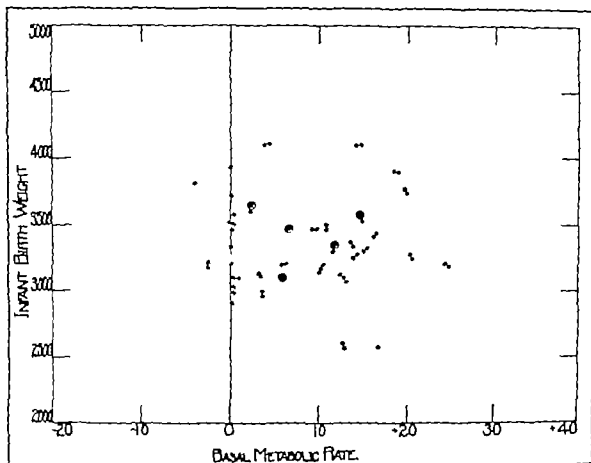


Fig. Scatter diagram of distribution of basal metabolic rates of 303 pregnant women and weights of their infants at birth. Horizontal axis, maternal basal metabolic rates. Vertical axis, infant birth weights in grams. Nine infants weighing less than 2000 grams are not included. Dots enclosed by circles represent two determinations falling at the same point on the chart. Note that there is no visible relationship between the two variables.

planned to determine whether a relationship exists between maternal basal metabolic rate and infant birth weight. With Matarese and Szenes and Mondré claiming that prolonged menstrual periods correlate with greater infant birth weights and with menorrhagia known to be associated with moderate hyperthyroidism it is suggested that low basal metabolic rates should correlate with large and high rates with small babies.

METHOD

Basal metabolic rates, each reading comprising a trial and an actual test, were done on 212 normal pregnant women taken in order of admission to the Obstetrical Service of the University Hospital. A few of these women

were occasionally admitted some weeks before delivery so that in an exceptional instance a reading was obtained as early as 80 days prior to the onset of labor, although the majority were made within 30 days of labor. The determinations were made as soon after admission as the women were adjusted to routine hospital life and were done by the indirect method based upon oxygen consumption with the respiratory quotient assumed to be 0.82 and the Roth Benedict apparatus being used. They were done according to the routine hospital technique and were interspersed with the daily work of the metabolic laboratory insuring reasonably consistent data, although the emotional element was not necessarily completely controlled. Only a

TABLE I.—MATERNAL BASAL METABOLIC RATES AVERAGED ACCORDING TO INFANT WEIGHT GROUPINGS

Birth weight of infants—grams	Average maternal B.M.R. (calculated arbitrarily)	Number of cases	Range of maternal B.M.R.
2,000 to 2,499	-11.0	3	-4.0 to -33.0
2,500 to 2,999	-11.8	30	-4.3 to -47.1
3,000 to 3,499	-12.8	41	-1.4 to -37.5
3,500 to 3,999	-9.9	5	-7 to -45.0
4,000 to 4,499	-11.1	17	-3.7 to -30.5
4,500 to 4,999	-1.1		-13.0 to -20.3

Nine infants weighed less than 2,000 grams and were not included in this table. Not that no relationship between the two variables, infant birth weight and maternal basal metabolic rate, is demonstrated.

single reading was obtained on each patient although the advisability of repeated tests is well recognized.

RESULTS

The maternal basal rates as determined ranged from minus 17.7 to plus 37.5 while the birth weights of the babies varied from 750 to 4,514 grams. Evaluation of the collected data was carried out in three ways.

The infant birth weights were arranged arbitrarily into six groups ranging from 0.000 to 4,999 grams in steps of 500 grams and the average maternal basal metabolic rate calculated for each group (Table I). Also the metabolic rates were arranged in six groupings and the average infant birth weight computed for each group (Table II). Nine infants weighed less than 1,000 grams and were not included in either table. Neither arrangement of the data shows any significant differences among the computed group averages.

A scatter diagram (Fig. 1) was drawn with maternal basal metabolic rates plotted along the horizontal axis and infant birth weights along the vertical axis. The lack of a relationship between basal metabolic rate and infant birth weight may readily be seen by a glance at the graph.

Finally correlations were computed for the series of 212 patients and a resulting coefficient of $\pm 0.057 =$ a probable error of 0.046 obtained. Such a low correlation indicates definitely that so far as the data of the present

TABLE II.—INFANT BIRTH WEIGHTS AVERAGED ACCORDING TO METABOLIC RATE GROUPINGS

Maternal B.M.R.	Average I.B.W., grams	Cases	Range of infant birth weights, grams
-20.0 to -10.0	3,801.0	4	3,634 to 4,010
-10.0 to -	3,746.0	13	3,645 to 4,300
0.0 to -10.0	3,551.1	73	3,506 to 4,310
-10.0 to -20.0	3,475.3	72	3,374 to 4,414
-20.0 to -30.0	3,413.1	25	3,415 to 4,515
-30.0 to -40.0	3,391.1	3	3,115 to 4,096

Nine infants weighed less than 2,000 grams and were not included in this table. Not that no relationship between the two variables, maternal basal metabolic rate and infant birth weight, is demonstrated.

study go no relationship exists between maternal basal metabolic rate and infant birth weight.

CONCLUSIONS

No predominating factor influencing infant birth weight has yet been demonstrated.

No relation was demonstrated between single basal metabolic rate determinations done by the indirect method on 212 normal, healthy pregnant women and the birth weights of their children.

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THE EFFECT OF PERITONEAL IRRITATION ON THE EMPTYING TIME OF THE GALL BLADDER AND STOMACH

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THE rôle of the sympathetic nervous system in relation to the altered function of various portions of the gastrointestinal tract has in recent years attracted much attention. The work reported in this paper was undertaken for the purpose of establishing a functional relationship between the autonomic nervous system and the gall bladder if such existed and to determine whether this effect was one of excitation or inhibition. The response of the gall bladder to remote peritoneal irritation offered a means of obtaining further evidence regarding the functioning of the gall bladder and also the possible relationship of the sympathetic nervous system to this organ. The effect of such peritoneal stimulation on the gall bladder was studied by means of roentgenograms following the intravenous injection of sodium tetradiodophthalein. The filling and emptying time as well as the ability of the gall bladder to concentrate the dye were observed and this correlated with the emptying time of the stomach as determined by roentgenograms following a barium meal.

That the gall bladder has a relatively rich nerve supply of both medullated and non-medullated fibers has been well established but the connections of these fibers and particularly their relations to the vagus and splanchnic nerves have not been clearly defined from an anatomical viewpoint. The functions of this abundant nerve supply have been the object of much investigation, but, unfortunately due partly to the variety of experimental procedures used, there have been many conflicting results. The earlier studies were chiefly directed toward the vagus and splanchnic nerves in an effort to establish their specified functions as regards the gall bladder, and the earlier investigators such as Heidenhain and Doyon believed that the splanchnic nerves were motor to the gall bladder. At a later date Courtaud and Guyon,

Bainbridge and Dale Lieb and McWhorter Westphal and others concluded that the vagus was the motor nerve to the gall bladder. Bainbridge and Dale also showed that splanchnic stimulation resulted in relaxation of the gall bladder. Freese concluded that the splanchnics contained both motor and inhibitory fibers. Mann in summing up the literature in 1924 concluded that 'as is seemingly true with the other viscera all the motor and inhibitory fibers do not run in the same nerves but some of each are found in the vagus and splanchnic nevertheless the vagus is mainly motor and the splanchnic mainly inhibitory to the gall bladder. All of the data were based on direct observation of the exposed or isolated gall bladder or on changes in pressure within the biliary system. In most instances the nerves were stimulated electrically and in some the changes were based on the action of drugs.

The advent of a means of visualizing the intact gall bladder permitted an experimental approach much more closely simulating normal physiology. Whitaker was the first to use this means of studying the nervous control of the gall bladder. His method was to inject iodized oil into the gall bladder following which he stimulated the nerves both centrally and peripherally. His conclusions were that the vagus and splanchnic nerves played no essential rôle in the emptying of the gall bladder. Boyden (3) observed that adrenalin was very effective in producing a diminution in the size of the gall bladder shadow, and interpreted this as a contraction of the gall bladder musculature although Burget thought this escape of bile could be accounted for by relaxation of the duodenum induced by the adrenalin. Copher, Kodoma and Graham (7, 8) studied the effects of electrical stimulation of the vagus in dogs following the intravenous injection of suitable dyes for visualizing the gall bladder. Their results suggested some

intestinal tract. The work here reported likewise indicates that the emptying of the gall bladder is under the control of reflex pathways associated with other portions of the gastrointestinal tract and it is probable that dysfunction and stasis of the gall bladder may be due in part to inhibitory reflexes arising from chronically diseased portions of the gastrointestinal tract. Likewise certain cases of postoperative vomiting may be explained as the result of gastric dysfunction by means of these reflex pathways.

SUMMARY

1 The effect of remote stimulation of the peritoneum on the emptying time of the stomach and gall bladder has been studied in dogs by means of roentgenograms

2 Such stimulation results in a delay in the emptying time of both the stomach and gall bladder

3 It is suggested that certain types of gastric and gall bladder dysfunction and stasis may be explained on the basis of these reflex pathways

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THE ABSORPTION FROM TRAUMATIZED MUSCLES¹

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THE toxemia theory of shock assumes that an absorption of toxic products from the injured area is responsible for the diminution of blood volume and the decrease in blood pressure. The experiments described in this paper were undertaken to determine the relative absorptive powers of traumatized and normal tissues. Underhill, Kapsinow and Fisk in studying burns found that "after a short latent period absorption from the burned area is much slower than it is under normal conditions."

The studies were performed on dogs. They were deeply anesthetized by sodium barbital (0.3 gram per kilogram of body weight) that was given intravenously. The animals gave no evidence of pain during the experiment and were killed at its completion. Muscle injury was produced by striking the thigh repeated hard blows with a hammer. The blows were not directed over the femoral vessels. The skin was not torn and the femur was not broken. The duration of the traumatization was approximately 5 minutes. Thirty minutes after the traumatization was terminated the phthalein or strychnine was injected into the injured muscle. The arterial blood pressure was recorded throughout the experiments.

Experiments with phenolsulphonephthalein The studies with phthalein included three groups of experiments: (1) those in which the dye was injected into the muscle of the anterior abdominal wall of normal dogs, (2) those in which the dye was injected into the anterior abdominal wall of dogs which had had one extremity traumatized and (3) those in which the dye was injected into the injured muscle of a traumatized extremity. A catheter was placed in the bladder at the beginning of the experiment and the bladder was emptied. Each animal received 12 milligrams of phthalein shortly after 350 cubic centimeters of tap water had been introduced by stomach tube. The phthalein excretion was determined at hourly intervals for the first 6 hours following its introduction. Further determinations were

usually performed 6 and 18 hours later. The results of these experiments are given in Table I.

From this table it is to be seen that there was very little variation in the dye elimination by the different normal animals. Most of the dye had been absorbed and excreted 4 hours following its injection. The average amount of phthalein recovered in the urine during the entire course of these experiments on normal dogs was 94.5 per cent of that injected. The percentage of phthalein recovered from the urine of dogs which had one extremity traumatized and the dye injected into the anterior abdominal wall varied from 80 to 97, the average being 87.5 per cent. The elimination of the dye was slower in these experiments than in those in which no trauma was carried out. A greater amount of the dye was recovered in the second hour than in the first.

When the dye was injected into the center of the traumatized area a smaller proportion of it was recovered. The average elimination was 53.8 per cent of that injected. Also the rate of elimination was considerably slower.

From these experiments it is evident that the absorption of the dye from injured muscle as compared with that from normal muscle is markedly diminished.

Experiments with strychnine The time of the onset of convulsions, the character of the convulsions and the effects on the animals were noted in 3 types of experiments: (1) those in which strychnine was injected into the anterior abdominal wall of normal dogs, (2) those in which the drug was injected into the anterior abdominal wall of dogs which had had an extremity traumatized and (3) those in which strychnine was injected into the injured muscle of a traumatized extremity. The amount of strychnine that was injected in all experiments was 10 milligrams per kilogram of body weight. The results of these experiments are given in Table II.

It is to be seen in this table that five normal anesthetized dogs received an injection of

TABLE I—INJECTIONS OF PHENOLSULPHONEPIHTHALEIN

Exp. No.	R F conc. Hg. and pithalein per cent	Hours following injection								Total pithalein recovered
				3	4	5	6		24	
Normal dogs. Dye injected into anterior abdominal wall.										
	R F	28	154	28	48					
	Pithalein	20	23	8	3					26
	R F	20	14	14	108		207	108	90	
	Pithalein	25	23	18	10			3		83
3	R F	24	125	106	116		94			
	Pithalein	22	20	19	3		2			28
	R F	150	60	160						
	Pithalein	20	26		3					23
5	R F	11	108	18	29		7			
	Pithalein	20	20	6	8		3			21
Average total elimination of pithalein										
										24%

Average total elongations of polyesters

44

Traumatized dogs. Dye injected into anterior abdominal wall

	N P	106	15	10	106	64	64	64		
	Phthalum	14	27	80	4	5				80
	N P	104	106	106	106	96	96	70		
	Phthalum	8	21	00	8		6	10		91
3	N P	114	120	28	22	12	110	76		
	Phthalum	7	18		9	20	4	8		87
	N P	30	26	74	23	20	73			
	Phthalum	4	9	72	20		6	12		86
5	N P	100	106	100			100	96	64	
	Phthalum	9	26	22	12	3				97
6	N P	11	122	60	18	24				
	Phthalum	8	6	21	16		6			81

Average total elongation of the whole

४३

Tramadolized dogs. Dye injected into center of injured area

	B. P.	193	194	1	113	190	198	23		
	Pinchulala	5	6	2	30	9	7	9		64
	B. P.	20	116	7	100	16	10	90		
	Pinchulala		1	30	8	7				51
3	B. P.	120	96	14	11	136	140			
	Pinchulala	3	17	10	4	19	10		10	64
4	B. P.		208	1	10	4	16	26		
	Pinchulala	3	1	13		11	19	3		61
	B. P.	10	30	96	76	26				
5	Pinchulala	8	8					15		67

Average total elimination of particulate

45

TABLE II.—INJECTION OF STRYCHNINE

Dosage 10 mgms. per kilogram of body weight

Exp. No.	Time between injection and first convulsion	Character of convulsion	General remarks
Normal dogs. Strychnine injected into anterior abdominal wall			
1	7 min.	Very severe	Dog died 1.45' after injection during a severe convulsion. B. P. 118 mm. Hg just before fatal convulsion.
2	21 min.	Severe	Survived. Dog killed 5 hours after injection
3	10 min.	Very severe	Dog died 2'15" after injection during a severe convulsion
4	15 min.	Severe	Dog survived. Killed 4 hours after injection
5	7 min.	Very severe	Dog died during severe convulsion 35 minutes after injection
Traumatized dogs. Strychnine injected into anterior abdominal wall			
1	10 min.	Severe. Short duration	Died 5'30" after injection. Death not preceded by convulsion
2	10 min.	Moderately severe	Died 5'15" after injection, probably of shock
3	6 min.	Severe	Died during severe convulsion 27 minutes after injection. B. P. was 110 mm. Hg just before fatal convulsion
4	16 min.	Severe	Died 2'20" after injection during a convulsion
5	11 min.	Severe	Died 30 minutes after injection
Traumatized dogs. Strychnine injected into injured area			
1	No convulsions		Gradual fall of B. P. Died of shock 34 minutes after injection
	2 hours, 10 min.	Few mild jerks	Died of shock 16 hours after injection
2	3 hrs.	One mild convulsion	Died of shock 5 hrs. after injection
3	1 hr. 30 min.	9 mild convulsions	Gradual fall of B. P. Died 2'5" after injection, probably of shock
4	1 hr. 0 min.	6 mild convulsions	Gradual fall of B. P. Died 3 hrs. after injection, probably of shock

strychnine into the anterior abdominal wall. The time between the injection and the first convulsion varied from 7 to 21 minutes in the different experiments. Three of the animals died after having severe convulsions. The 2 remaining dogs had severe convulsions but survived.

In 5 experiments one of the posterior extremities was traumatized and strychnine was injected into the anterior abdominal wall. The onset of convulsions varied from 6 to 20 minutes following the injection. The convulsions were quite severe in four of the five experiments. All the animals died. In two experiments, death occurred during a severe convulsion. Death was probably due to the trauma in 2 animals which lived for more than 3 hours following the injection. There were no convulsions for a considerable period preceding the death of these 2 animals. In the remaining experiment in which the animal lived 50 minutes, death occurred 10 minutes

following a severe convulsion and it was not known whether the animal died as a result of the administration of the strychnine, or the trauma, or both.

No severe convulsions were produced by the injection of strychnine in the 5 experiments in which it was introduced into the injured muscle. Four of the animals had mild convulsions. The time separating the injection of strychnine and the onset of convulsions varied from 1 hour and 10 minutes to 3 hours. The animals which had convulsions lived from 2 hours and 5 minutes to 16 hours following the injection of strychnine. Death in all instances was almost certainly due to the trauma and not to the strychnine.

These experiments show that the absorption of strychnine from the anterior abdominal wall is altered very little by trauma to an extremity. On the other hand, strychnine is absorbed very slowly when it is introduced into the traumatized area itself.

SUMMARY

The absorption of phenolsulphonephthalein and of strychnine by deeply anesthetized dogs has been studied under three experimental conditions (1) normal dogs in which the injections were made into the anterior abdominal wall (2) dogs with a traumatized extremity in which the injection was made into the anterior abdominal wall and (3) dogs with a traumatized extremity in which the injection was made into the injured muscle. There was not a great deal of difference in the absorption of the solutions that were injected into the

anterior abdominal wall of normal dogs and of dogs with a traumatized extremity except for a slight delay in the latter group. On the other hand the absorption of the phenolsulphonephthalein and of the strychnine that was injected into the traumatized area itself was greatly retarded.

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THE CONCEPTION PERIOD IN NORMAL ADULT WOMEN

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THE epoch making work of Aschheim and Zondek has definitely shown that hormonal secretions play a prominent rôle in pregnancy. These hormones are derived from the ovary and the pituitary gland and bear a direct relationship to ovulation, fecundation and menstruation. Recent investigation indicates that there are seven distinct hormonal effects from the pituitary gland and two from the ovary. The effects from the pituitary gland are

1. The anterior lobe.

a. An effect causing ripening of the graafian follicle with the production of folliculin and egg cell (1)

b. An effect which causes growth of the corpus luteum after ovulation (2)

c. An effect which in conjunction with the corpus luteum causes hypertrophy of the mammary glands (3 5 11 13 18 24)

2. The posterior lobe

a. An effect causing uterus stimulation (12 13 18)

b. An effect causing expansion of melanophores (35)

c. An effect causing antidiuretics or water retention (32)

d. An effect causing increased blood pressure (9)

The effects from the ovary are

a. Folliculin which causes hyperemia of the uterus and tubes in preparation for the egg cell (7)

b. Corpus luteum which produces further growth of uterus and hypertrophy of mammary glands (6 8)

Ripening of the graafian follicles with the production of folliculin and ovum is brought about by an anterior pituitary hormone. Folliculin causes hyperemia of the uterus and tubes. When the follicle bursts the corpus luteum spurium is formed and this body in turn causes further growth of the uterus and hypertrophy of the mammary glands. If the egg cell is not fertilized the corpus luteum withers and dies and menstruation takes place. If the fertilized egg is implanted the corpus luteum spurium develops into the corpus luteum graviditatis, which maintains pregnancy and when it begins to wither the posterior lobe hormones re-assert causing rhythmic contractions of the uterus and labor. These reactions are shown by Figures 1 and 2 (13 14 15 30)

Different scientists have shown that the life of the human egg cell is 1 day (18, 24, 34) and that of the sperm cell is 2 to 3 days (18 24, 36). Also that in a normal regularly menstruating woman with a cycle of 28 to 30 days

ovulation occurs between the fourteenth and sixteenth days (18, 24) and that 10 days are required for the passage of the egg cell through the fallopian tube (18)

Henle has definitely shown that spermatozoa are able to travel a distance of 1 centimeter in 3 minutes (37). That human spermatozoa may reach the fallopian tube in a very short time after being deposited in the female genitalia there can be no doubt as shown by the following case which we observed

Mrs. B. M. age 25 1 para diagnosis dyspareunia prolapsed uterus. In this case the last coitus was 65 days previous. Examination of vaginal and cervical secretions did not show the presence of spermatozoa. Copulation was had at 8 a.m. 2 hours later at laparotomy examination of fallopian tubes revealed the presence of numerous spermatozoa

If the duration of life of the egg and sperm cell is known as well as the rate of sperm cell motion the next question which confronts us is: When is the egg cell liberated?

Knaus by means of a manometer noted that there was increased uterine pressure following the injection of posterior lobe pituitrin due to uterine contractions and that when corpus luteum was present the uterus did not respond by contractions (36). In this manner he was able to determine the time of ovulation. This he found to be in the 28 day cycle of menstruation on the fourteenth to the sixteenth days before the next menstruation (18, 24). From these facts it is evident that in a 28 day cycle the corpus luteum spurium functions for about 14 days, when implantation of a fertilized egg occurs the corpus luteum spurium is changed to corpus luteum graviditatis or if fertilization and implantation do not occur it withers and dies and menstruation is brought about. On this view pregnancy is not a hit and miss affair but is regulated by the meeting of the egg and sperm cell before one or the other has withered and died (18, 36).

Ogino of Japan, studied this question by examining the coitus in relation to ovulation and noting its ability to fecundate. He arrived at the following conclusions

1. For women regularly menstruating every 28 days the period of time the human sperm cell was able to impregnate the ovum was the 8 day period lying between the twelfth and the

nineteenth day before the next menstruation or in other words between the tenth and the seventeenth day after menstruation had started, other days being physiologically sterile

2. If the cycle is longer or shorter than 28 days the period of conception is moved so many days ahead or behind

3. For those women who do not have a greater variation in the menstrual cycle than 10 days a formula for the period of conception could be stated as follows

Beginning of conception is 10 plus cycle of minimum days—28

End of conception period is 17 plus cycle of maximum days—28

4. In computing the period of conception of any woman 12 menstrual cycles should be known noting the maximum and minimum length of time of each. If the menstrual cycle should vary more than 10 days then the formula is still theoretically correct but of not much practical value (31)

Knaus of Austria working independently arrived at similar conclusions, but elaborated them more fully as follows

1. For women with a regular menstrual cycle of 26 days, conception possibilities are limited to the time from the ninth to the thirteenth days inclusive

2. For women with a regular menstrual cycle of 27 days conception possibilities are limited to the time from the tenth to the fourteenth days inclusive

3. For women with a regular menstrual cycle of 28 days conception possibilities are limited to the time from the eleventh to the fifteenth days inclusive

4. For women with a regular menstrual cycle of 30 days conception possibilities are limited to the time from the thirteenth to the seventeenth days inclusive

5. For women with a regular menstrual cycle of 34 days, conception possibilities are limited to the time from the seventeenth to the twenty first days inclusive

6. For women with a regular menstrual cycle of 28 to 30 days conception possibilities are limited to the time from the eleventh to the seventeenth days inclusive, with the maximum of same at the fourteenth to the sixteenth days



Fig.

7. For women with a regular menstrual cycle of 26 to 30 days, conception possibilities are limited to the time from the ninth to the seventeenth days, inclusive of the menstrual cycle.

For menstrual cycles of other variations, the conception period may be computed in the same manner as stated above. These calculations being true only for normal healthy women with regular variations in the cycle as stated above (16 to 19 to 29).

Ogino established the time of ovulation in an empirical manner during the course of laparotomies on women. He has a 5 day ovulation period in a constant menstrual cycle.

Knaus determined the time of ovulation by measuring the uterine contractions by means of a manometer. He has a 2 day ovulation period in a constant menstrual cycle. It seems to us that Knaus method is more definite and precise therefore we follow the doctrine of Knaus.

Based upon this initial research we decided to study this question by examining the coitus at various times to determine its ability to fecundate. Our material was chosen from 87 apparently normal couples including 8 nationalities and 735 copulations. Where pregnancy was thought to have occurred it was checked by the modified Aschheim-Zondek test on rabbits.

Our observations are as follows:

CASE 1. E. B., aged 36 years. Menstruation commenced at the age of 13, was of regular cycle, 28 to 30 days duration 4 to 5 days. Patient was married at the age of 26 on the thirteenth day after previous menstruation, result pregnancy. For 5 years after birth of child, not desiring more children, various contraceptive methods as suppositories, douche powders, and pessaries were used. During the fifth year, while wearing a pessary she became pregnant and aborted at the second month. At this time she was informed by a friend to abstain from coitus between

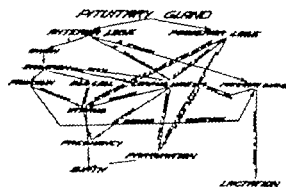


Fig. 1

the tenth and twentieth day of her menstrual cycle. This she practiced successfully for 13 years without the use of any contraceptive measures whatever except accurately noting the dates on the calendar as well as duration of each cycle as the months went by. At the beginning of her fourteenth year of this procedure she was informed that she must not figure from the first day of menstruation but from the last. She accordingly changed her system. The next and only coitus occurred on the fourteenth day from the beginning of the last menstrual period. Result amenorrhea, of 3 months. On the third day after the second missed cycle the Aschheim-Zondek test revealed pregnancy. Ten days later by self-induced means, she aborted a 3 months fetus. In this case the cohabitation date lies within the period of conception for her.

CASE 2. F. E., aged 28 years. Menstruation began at the age of 14 years, was occurring every 26 to 28 days, duration 4 days. She was married at the age of 25 the date being about halfway between two menstruations. Result pregnancy. Following birth of child she developed a painful right ovary. Menstruation became profuse, 5 to 6 days in duration, varying from 26 to 34 days. She was advised by her physician that another pregnancy might result in an operation being necessary so she used various contraceptive measures for 6 years. At this time, feeling that her procedure was correct, she adopted a son. Later she was advised that contraceptives were injurious and unnecessary. If she would abstain from intercourse between the eleventh to the seventeenth days of menstrual cycle. The previous 4 periods were as follows: 26, 30, 28 and 33 days in duration. The only cohabitation during the month was on the nineteenth day after the beginning of the last menstruation. Result amenorrhea. The Aschheim-Zondek test proved the existence of pregnancy. This day lies within the dates of conception possibilities for her.

CASE 3. A. A. aged 25 years. Menstrual cycle varied from 29 to 33 days, duration 4 days. Last 4 menstruations were as follows: January 27, 1932; February 20, 1932; March 20, 1932; April 30, 1932. Only cohabitation on May 16, 1932, then amenorrhea. The Aschheim-Zondek test on June 22, 1932, proved the existence of pregnancy. The cohabita-

TABLE I.—CASE 1 A. F

M.	Days	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31
5-8		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
6-1		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
6-30		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
7-25		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
8-23		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
9-19		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
10-14		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
11-30		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
12-6		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
1-4		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
2-1		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
2-18		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■

■ Menstruation ■ Period of conception. / < Maximum period of conception. □ Cohabitation.

tion date in this case falls within the conception period for this woman.

CASE 4 A. R. aged 26 years. Menstrual cycle was 27 to 33 days, duration, 4 days. The last 5 menstruations are as follows January 2 1932 February 3 1932 March 1 1932 April 3 1932 and May 4, 1932 Only cohabitation was on May 18 1932 The next menstruation due to occur during the first week in June failed to materialize by June 16 on which date the Aschheim Zondek test proved the existence of pregnancy The cohabitation here is within the period of conception possibilities for this cycle.

CASE 5 A. N. aged 42 years, vi-para 3 abortions. Menstrual cycle was 30 to 31 days. Last two menstruations were as follows January 10 1932 and February 10, 1932 The only coitus was on February 25 1932 The following day her husband left home to seek work in a distant state and was gone for 4 months. This woman did not menstruate during the next 3 months. Being in ill health and believing that she was entering upon the climacteric she consulted a physician. The Aschheim Zondek test proved pregnancy was the cause of amenorrhoea.

CASE 6 W. E. aged 22 years, regular 26 to 28 day cycle menstruation. Confined on August 14 1931 First menstruation postpartum was December 25 1931 Next four as follows January 22 1932 February 17 1932 March 16 1932, and April 14 1932 One coitus occurred on April 30 1932 On May 14, 1932 Aschheim Zondek test was positive for pregnancy

CASE 7 E. A., aged 21 years. Regular menstrual cycle 26 to 30 days. Last menstruation was on April 6 1932 Cohabitation was on April 22 1932 On June 11 1932 Aschheim Zondek test was positive for pregnancy

CASE 8 A. B. aged 40 years viii-para men- struation every 16 to 27 days duration 2 to 3 days. Last menstruation on August 10 1931 cohabitation

on August 31 1931 On September 18 1931 Aschheim Zondek test was positive for pregnancy. In her case the conception date lies on the second day of the period of conception for her

CASE 9 H. L. aged 35 years, no children regular menstrual cycle of 30 days duration 5 days. Last period was February 29 1932, cohabitation March 13 1932 Result pregnancy

CASE 10 H. C., aged 21 years, on August 27 1925 was confined. This woman believed that as long as she was nursing a child and did not menstruate that she could not become pregnant. Feeling secure in this belief no contraceptive measures were used Eight months after her confinement, no menstrua- tion having appeared as yet on October 12 1926 she consulted a physician and pregnancy was diagnosed She was again confined. In this case no menstrua- tion occurred between the birth of the first child and the birth of the second child.

COHABITATIONS REGULATED BY TIME WHICH DID NOT RESULT IN PREGNANCY

CASE 1 A. F., aged 27 years i-para. This woman used the premenstrual and postmenstrual period of sterility for cohabitation The details are shown in Table I

In this case there were 48 cohabitations which did not result in pregnancy

Eighty-seven cases consisting of 12 different menstrual cycles and 8 nationalities were studied for the period of physiological sterility The details of this study are shown in Tables II and III

Cohabitations before and after menstrua- tions total 725 and not a single cohabitation of these two groups resulted in pregnancy

TABLE II

Cases	Cycle	Months	Days before next menses														Total
			3	7	10	9	8	7	6	5	4	3	2	1			
2	26-27	4							3			5	6	4			21
3	26-28	6					1		7		10		9	14			49
9	26-30	3						6	9	2			4	8			29
3	26-34	4								4		5	3	7			23
6	27-33	5							3	9	4	6	10	3			7
3	28-30			4			6			9		8					29
	28-34	5															5
	28-36									8	4		5	6			24
7	29-32	3							8		7	3					20
	29-30	5						3			2						5
	30					4					7		3	4			23
5	30-3			7		10		4	7				9	1			30
By				4		14	8	9	4	45	47	44	64	8			37

TABLE III

Cases	Cycle	Months	Days after menstruation														Total
					3	4	5	6	7	8	9	10					
3	26-27				3	4											
3	26-28	6	8	7	18	14											47
9	26-30	3	14	8	14												48
	26-34				6	8											24
6	27-33	5	10	8													40
3	28-30		28	4			7										71
	28-34	5			3		4										20
	28-36																8
	29-30	5	3		1												6
7	29-32	3	3	1		9	8										3
	30		10	3			4										29
5	30-3			3			4										31
By			6	48	7	90	26										254

SUMMARY

The anterior lobe secretion motivates the ovary. The corpus luteum inhibits the posterior lobe secretion and maintains pregnancy. When the corpus luteum withers the oxytocic principle of the posterior lobe secretion asserts itself and labor is brought about. Fecundation is only possible when the sperm cell is properly timed to meet the egg cell.

CONCLUSIONS

1 Hormones play a major rôle in pregnancy.

2 The sperm and egg cells detached from their respective breeding places have a very limited time to live. For the egg cell it is not longer than 1 day. For the sperm cell it is 2 to 3 days.

3 Every normal regularly menstruating woman has a definite ovulation period.

4 Every normal regularly menstruating woman has a definite period of physiological sterility and a definite period of fertility in each cycle.

5 Cohabitation must be properly timed with ovulation if pregnancy is to result.

6 Pregnancy may be brought about or avoided at will by the observation of these two periods of time

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THE INTERRELATIONSHIP BETWEEN OVARIAN FOLLICLE CYSTS HYPERPLASIA OF THE ENDOMETRIUM, AND FIBROMYOMATA

A POSSIBLE ETIOLOGY OF UTERINE FIBROIDS

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UTERINE fibroids, because they are the most common of all pelvic neoplasms should command the interest of every gynecologist. Various theories of their origin have been propounded, but no accepted explanation has yet been advanced and their true histogenesis will probably remain a mystery until the cause of neoplasms in general is discovered. However, recent additions to our knowledge concerning the ovarian and pituitary hormones now offer a definite approach to the origin and development of these benign tumors. Past research into the pelvic field has revealed the interrelationship of ovarian follicle cysts and hyperplasia of the endometrium and although in the evidence brought forth there exists numerous instances of the association of fibromyomata with these two conditions, the action of ovarian dysfunction on the myometrium has been little investigated or commented upon. I believe that the existence of an etiological relationship between hyperplasia of the endometrium, ovarian follicle cysts, and fibromyomata is highly probable and the results of my investigations have prompted the writing of this paper.

The histogenesis of fibroids is not definitely known, and lends itself to the explanations given to neoplasms in general: an origin from embryonic rests (Conheim) a product of connective metaplasia etc. McCallum is one of the few advocates of Virchow's uterine muscular origin theory and he contends that this belief is substantiated by the fact that myomata relax and soften during pregnancy and recover their hardness after confinement. Opitz suggests metaplasia of connective tissue since both uterine muscle and connective tissue originally develop from the same undifferentiated process of the mesenchyme continuation or repetition of this metaplastic process must occur to produce fibroids.

Rocager is of the opinion that fibroids arise from the walls of the blood vessels but this belief is not substantiated by Cullen. A relationship between uterine fibroids and the terminal branches of uterine arteries similar to that found between neuromata and the epineurium has been suggested. Other observers note an inflammatory cause. von Recklinghausen considers wolffian remnants to be important in their origin, while still others believe that the development is to be found in the aberrant muellerian tissue. Ewing is of the opinion that the essential histogenetic factor is an embryonic disturbance in the structure of the uterus because of the remarkable degree of isolation of the many myomata, their widespread occurrence over the body other than in the uterus and the presence in many cases of heterotopic inclusions, epithelial cartilaginous osseous, fatty and rhabdomyomatous, clearly point to an embryonic origin.

Numerous cases have been reported which seem to show that heredity may play some part in the etiology of fibroids although only 21 women in Lynch's series of 683 cases gave an indicative family history. The relative frequency of this type of tumor in negroes suggest the influence of race as a factor. In Charity Hospital New Orleans, where the annual admission of the white and colored patients is about equal, fibromyomata were noted 9 times as frequently in the colored patients as in the white. Bulloch describes this growth and other fibroid tendencies of the negro as a racial peculiarity, though there is a general impression extant that these growths were unknown among the primitive tribes. Why there should be any relationship between the development of fibroids and the advancing civilization of negro women is difficult to understand unless, as will be discussed in a subsequent paper, ovarian dys-

function brought on by pelvic infection should play an etiological rôle. However scientific data are still wanting to confirm definitely that either heredity or race is the cause.

Sterility has long been noted as another factor in the etiology of fibroids since it is found to be three times as prevalent in association with fibroids as it is under normal conditions. Young and Williams (Lockyer) note 10.5 per cent sterility in all women who have attained the age of 38 while in a large series of cases of fibroids Cullen, Phillips, Olhausen and Lynch found 30 to 33 per cent sterility in the married woman. It is an accepted fact that fibroids occur most frequently in virgins and in absolutely or relatively sterile women. One child sterility is frequently observed and in Miller's 150 cases of fibroids 50 per cent of the fertile colored women had only 1 child. Lynch and Cullen offer as an explanation of this observation the fact that uterine muscle is primarily designed to respond to pregnancy in all of its various functions and manifestations and should no pregnancy intervene this organ responds to a less influential stimulus and hypertrophies in an abnormal fashion resulting in the development of fibroids. This theory however does not offer any explanation of the development of fibroids in a parous woman, nor does it explain their stimulation to rapid growth when associated with pregnancy. Fibroids because of their size and pressure and the high incidence of associated infection, often cause mechanical sterility. Both sterility and fibromyomata are prone to develop in the infantile type of uterus as well as from displacements and other uterine defects which often enhance the early termination of the pregnancy by abortion. The essential problem is whether sterility is the cause of fibroids or fibroids the cause of sterility.

In view of the fact that the occurrence of fibroids is generally noted during the child bearing years of woman menstruation should play an important part in their etiology. On this hypothesis Sampson offers as an explanation local hyperplasia of the uterine muscle cells caused by the stimulus of men-

strual blood which has acquired access to the myometrium by retrograde flow through the venous sinuses of the endometrium. As proof, the author cites the fact that smooth muscle tissue in contact with heterotopic endometrial tissue, often shows a tendency to grow. The absence of fibroids in the tubes and in the cervix is explained by lack of menstruation in these parts. Sampson suggests that the cause of the greater frequency of fibroids in the human female over that in the lower animals is due to the monthly periods in woman since the animal cycle is not true menstruation. Moench points out however that menstruation does occur in the ape and that fibroids are relatively unknown in this animal.

There is a general clinical impression that glandular dysfunction is associated with fibroids. Polak's observation of unbalanced glandular patients lead him to believe that the hyperpituitary type of woman, who begins her menstrual life with an anteverted anteфлекted uterus, and a relative large uterine body is prone to develop fibroids. He has followed 100 or more women over a 10 to 15 year period and has "watched them grow fibroids." Fibroids often develop in the subthyroid and the subpituitary types with anteфлекted retroverted uteri, and with clinical symptoms of glandular hypoplasia, primary dysmenorrhea and sterility. On the other hand, women of perfect endocrine balance seldom grow fibroids even though pregnancy is a frequent occurrence, with the uterus passing through alternate periods of hypertrophy and involution. In reviewing 683 cases of fibroids, Lynch observed thyroid involvement, adenoma, hyperthyroidism or simple goiter singularly or in some combination, in 106 patients (15.5 per cent). In 394 cases of large fibroids the abnormality of the thyroid was involved in 77 patients (19.5 per cent).

Ovarian activity has generally been considered a factor in fibroid development because of its occurrence during woman's functional years, and while this consideration has been based only on clinical observations and general impressions its existence evidences a trend of thought along the line of ovarian hormone influence on the uterus. Schroeder and R. Meyer, in Germany and

Novak, Fluhmann and Graves in this country have brought forth convincing evidence to prove the relationship between ovarian follicle hormone and hyperplasia of the endometrium. This pathological condition manifests itself as irregular uterine bleeding which is most frequently noted clinically at the two extremes of woman's functional years, and histologically is described as containing a characteristic lack of uniformity of the glandular elements embedded in a varying amount of densely packed stromal proliferation, the so-called Swiss cheese pattern. Because of its microscopic resemblance to hypertrophy of the basal layer of the endometrium the hypothesis is logical that its structure results from overgrowth of this layer at the expense of the superficial layers whose growth is governed by the hormone of the corpus luteum.

Schroeder had an opportunity of examining the uterus and both ovaries in 62 cases of hyperplasia of the endometrium. In 53 instances the ovaries contained 1 or more small cysts lined with well preserved granulosa and theca layers in a few instances the ovum was demonstrated in the granulosa cells. In the 9 remaining cases the follicles were undergoing degeneration and one early corpus luteum was seen, but was thought to have been ruptured a few days previously by bimanual examination. From these observations Schroeder proposed the theory of 'pathological persistence of a ripening follicle' as the cause of hyperplasia of the endometrium. He contends that the ovum does not die and the follicle unruptured, continues to function resulting in excess secretion of the follicle hormone. R. Meyer substantiated the evidence of the absence of the corpus luteum formation in hyperplasia but he noted large cysts of the ovaries caused from apparent follicle atresia in addition to the many normal granulosa cell cysts. The walls of the larger cysts presented an unusual hypertrophy of the theca cells. Theorizing from these observations, Meyer advanced the idea that the ovum dies prematurely due to some unknown inherent weakness and in consequence the follicle does not reach complete maturity nor does it rupture but undergoes atresia at an earlier period. Immediately another

ripening follicle appears and the process is repeated thus maintaining continuous ovarian follicle stimulation to the endometrium. Even though the explanations of Schroeder and Meyer of the methods of production of the follicular hormone differ they completely agree that continuous stimulation by it in the absence of corpus luteum influence is the cause of hyperplasia of the endometrium.

In a smaller series of cases Fluhmann, Graves, and Novak generally support this hypothesis as the cause of endometrial hyperplasia as attested by the following facts: (1) it is observed only during woman's functional years (2) it occurs at the two extremes of woman's menstrual life when the ovarian cycle tends not to follow its normal rhythm, since it is just beginning or ending (3) there is no evidence of inflammatory origin since it occurs in very young girls (4) the bleeding resulting from it is checked by removing the ovaries and destroying ovarian function by X-ray (5) curettage gives only temporary relief suggesting that the underlying cause has not been reached (6) the presence of follicle cysts is constantly found and excess follicle hormone content is noted in the blood at such periods (7) estrin has been proved experimentally to be a growth hormone to endometrial glands and stroma and hyperplasia presents similar histological characteristics (8) it found after the menopause from granulosa cell tumors which give rise to excess estrin or hyperestrinism (Graves) in the blood (9) the absence of corpus lutea precludes the formation of progesterin (10) and the lack of progesterin the corpus luteum hormone is confirmed by the absence of endometrial secretory changes, normally produced by this hormone.

Since the discovery of the 'motor control' of the anterior pituitary gland over the ovarian function Novak and Burch have suggested the anterior hypophysis acting through the ovary as being the fundamental etiological factor of hyperplasia of the endometrium. According to Novak the interrelationship of the anterior hypophysis is chiefly responsible for the alternating phases of the long continued amenorrhea and persistent bleeding seen in the familiar type of

adiposogenital dystrophy. The participation of this gland as an etiological factor is further suggested by the cases of functional bleeding occurring after full term pregnancies or miscarriages since it is well known that the anterior pituitary gland undergoes marked hypertrophy during gestation. Novak has obtained splendid clinical results from the treatment of functional bleeding by the administration of anterior pituitary hormone, while Burch has demonstrated experimentally that there is a definite cyclic variation in the capacity of the anterior lobe to produce ovulation.

From the above evidence it seems legitimate to conclude that hyperplasia of the endometrium is the result of the unopposed and continued action of the ovarian follicle hormone in the absence of the corpus luteum influence. If this be true the reverse ought to hold namely, when endometrial hyperplasia is found in curettings the diagnosis of ovarian follicle cysts can be assumed. Since the uterus as a whole is involved in the reproductive process it seems logical to deduce that the action of estrin is not limited solely to the endometrium but that the myometrium is also involved, especially if there be pathological stimulation to this myometrial tissue at the same time that the endometrium is abnormally stimulated to hyperplastic formation.

Novak has observed in evidence presented but unmentioned upon the association of ovarian follicle cysts, hyperplasia of the endometrium, and fibromyomatous changes in the myometrium. In 32 uteri with hyperplastic characteristics of the endometrium he found myomatous involvement of the myometrium in 23 cases (71.8 per cent). In 15 cases the myomata were alone; 5 were combined with adenomyomata and in 3 cases the latter growth alone was present. Turco comments upon the cystic degeneration of the ovaries in 11 cases of fibroids, but concludes that it is difficult to tell whether degeneration of the ovaries was the result or cause of the fibromyomata. Graves in 237 cases of hyperplasia treated with radium, noted fibroids clinically in 50 per cent. In 25 cases of fibroids in which hysterectomy and bilateral

oophorectomy were done, he found 11 cases of hyperplasia. In the same communication this author discussed uterine bleeding with and without fibroid association; his conclusion was that abnormal uterine bleeding associated with fibroids is identical in etiology and character with the so-called idiopathic or functional uterine hemorrhage characterized by the "Swiss cheese pattern" of the endometrium except in cases of pedunculated degenerating and submucous fibroids, and exposed adenomyomatous growths.

Since the rate of growth of fibromyomata is not exceedingly rapid except in pregnancy, malignancy and possibly in youth it would seem legitimate to assume that if these growths are the results of the unopposed estrin stimulation of the myometrium their appearance would be slower than the hyperplastic endometrial changes. Hence it might be concluded that the unopposed action of estrin on the uterus results (1) in immediate endometrial changes, characterized by hyperplasia and (2) in more latent myometrial pathology in the nature of fibromyomatous growths.

With this hypothesis as a basis an analysis was made of 26 cases of hyperplasia of the endometrium in which operation was done and diagnosis as such made, and in which a second operation was performed for fibromyomata after an approximate interval of 4 years and 4 months. In addition 124 cases of fibromyomata which were diagnosed microscopically, are offered with the associated ovarian and endometrial findings as presenting added evidence in support of a cause and effect relationship and suggesting a possible factor in the development of uterine fibroids.

I. In the first group of 26 cases of hyperplasia of the endometrium a curettage was performed, and in no instance was a fibromyoma determined clinically or grossly at the time of this operation even though the abdomen was opened in 13 cases (50 per cent). After varying intervals all 26 patients were operated upon again because of uterine fibroids, and the findings of the ovaries, endometrium, and myometrium are offered (Table I).

TABLE 1.—ANALYSIS OF TWENTY SIX CASES

	Cases	Condition of myometrium	Cases
Age in years		Fibromyomatous	26
30 to 39	4	Hyperplastic	6
30 to 34	10	Fibrotic	5
35 to 39	9	Malignant degeneration	1
40 to 44	8	Adenomyomatous	1
45 to 49	1	Normal	1
Total	26	Metritis	1
Age group 30 to 39 represents 73 per cent of cases.		Bicornuate uterus	1
Social status		Condition of endometrium	
Married	21	Hyperplastic	24
Single	5	Premenstrual	3
Fertile	15	Ovaries	
Sterile	6	Both examined	13
Miscarriage, but no full term pregnancy	3	All ovaries thus examined	5
Symptoms		Only 1 ovary examined	8
First operation		18 cases, 69.2 per cent.	
Menorrhagia	13	Condition of ovaries at second operation	
Metrorrhagia	6	Follicle cysts	26
Dysmenorrhoea	7	Corpus luteum	
Second operation		Mature	8
Menorrhagia	6	Degenerating	5
Metrorrhagia	3	Absent	19
Dysmenorrhoea	9	Miscellaneous	
Abdominal mass	5	Salpingitis	11
Nervous, irritable	5	Adhesions	14
Amenorrhoea after radium	3	Endometrial transplants.	17
Effects from radium	4		
Pregnancy after dilatation and curettage	2	96 per cent.	
Lasted 3 and 6 months		127 per cent.	
Type of operation			
Dilatation and curettage	20		
Application of radium	6		
Superficial of uterus	3		
Appendectomy	4		
Unilateral salpingo-oophorectomy	5		
Bilateral salpingectomy	1		
*In 1 patient dilatation and curettage was done twice, in another three times.			
†Number of hours undetermined			
‡Abdomen opened in 13 cases, 50 per cent of total.			
Condition of ovaries at first operation			
Diagnosed microscopically as cystic	5		
Diagnosed operatively as cystic	5		
Not mentioned at operation	3		
Curettings			
Abundant	4		
Moderate amount	8		
Small amount.	4		
Polypoid	4		
Not mentioned	8		
Time interval between operations			
Longest	13 years, 2 months		
Average	4 years, 4 months		
Shortest.	1 year 2 months		
Type of second operation			
Hysterectomy	26		
Bilateral salpingo-oophorectomy	13		
Removal of all ovarian tissue	8		
Unilateral salpingo-oophorectomy	8		

The age limits were well within woman's functional years 30 to 39 years accounting for 73 per cent of all patients, the average being 35 plus years. The symptoms between the first and second operations offer an interesting comparison the outstanding feature of which is an increase of complaints. Menorrhagia and dysmenorrhoea were more frequent after the first operation while metrorrhagia decreased. An abdominal mass appeared in 5 instances, while nervousness in the form of irritability became a complaint in a similar number of cases. Radium caused a temporary amenorrhoea in 2 cases for 3 and 6 months, respectively but was non-beneficial in 4 cases. Pregnancy occurred in 2 women after the initial curettage. The interval between the first and second operation averaged $4\frac{1}{3}$ years, with limits of $1\frac{1}{6}$ years to $13\frac{1}{6}$ years. Twenty-nine curettages were performed including 2 on 1 patient and 3 on another. The abdomen was opened at the first operation in 13 cases (50 per cent) and in 5 patients the ovaries were diagnosed microscopically as containing follicle cysts. In an equal number of cases the

operator noted the same condition grossly and punctured the multiple cysts with a needle. No mention of the operative condition of the ovaries could be found in the operative notes of 3 patients whose ovaries were not disturbed. The amount of curettements was described in 18 instances but since many different doctors performed the 29 curettages the description of the curettements naturally varies with the individual operator.

The uterus was removed in every instance at the second operation. Bilateral salpingo-oophorectomy was performed in 13 cases while all the remaining ovarian tissue was excised in 5, a total of 69.2 per cent. One ovary was left *in situ* in 8 cases. Multiple fibroids were observed in every case and in general the longer the interval between the operations the larger the fibroids. The myometrium was normal in 11 cases (42.3 per cent) even though fibroids were present in the walls. Hypertrophy of the myometrium was noted in 6 instances (23.3 per cent) and fibrosis i.e. increased connective tissue in 5 cases (19.2 per cent). The endometrium was either hyperplastic or polypoid in 24 cases (92.3 per cent), the premenstrual pregestational stage was observed in 2 instances associated in each case with a developing corpus luteum and interestingly enough it occurred in the 2 patients who had borne children after the initial curettage for hyperplasia of the endometrium. The fibroid tumors in these 2 cases were multiple but small.

Unless both ovaries or the total ovarian tissue are studied in their entirety it is unwise to draw conclusions concerning the presence or absence of the corpus luteum since its absence is so importantly related to hyperplasia of the endometrium. In 18 cases (69.2 per cent) both ovaries or the total remaining ovarian tissue were studied. In 8 cases (30.8 per cent), in which only 1 ovary was available for study 2 corpora lutea were observed in the developmental stage, and in each case the secretory phase of the endometrial cycle was associated. In 24 cases (92.3 per cent) no mature corpus luteum could be found, while old degenerating luteal cysts were observed in 5 instances. Follicle cysts of the ovaries were

present in all 26 cases including those in which the corpora lutea were found. Any explanation I can offer of the presence of follicle cysts in association with a developing corpus luteum must be in the nature of an hypothesis. That hyperplasia of the endometrium is not always a permanent condition has been observed frequently in young girls many of whom subsequently bear children, yet its persistence is noted as long as follicle cysts are found in the ovary. However when menstruation begins to return to normal ovulation with the usual subsequent corpus luteum formation must occur and at such periods the change from abnormal functional bleeding over to normal menstruation the existence of both follicle cysts and corpus luteum might be observed.

In 25 cases (96.1 per cent) salpingitis or adhesions from previous operations or endometrial transplants were noted involving the ovaries. The importance of this finding as a possible etiological factor in follicle cyst formation with subsequent ovarian dysfunction is not to be minimized. The endometrial transplants, mainly to the ovaries (71.4 per cent) were noted in 7 cases (27 per cent). The rather high percentage of this condition associated with hyperplasia of the endometrium and fibroids as compared with other gynecological conditions in general is noted as a possible etiological factor of endometriosis.

These 26 cases of hyperplasia of the endometrium on which a second operation was performed on an average of $4\frac{1}{2}$ years later for myomatous growths of the uterus are convincing evidence of a cause and effect relationship of the prolonged and unopposed action of estrin on the myometrium and the development of fibromyomata.

II. A second group of 83 patients on whom hysterectomy was performed for fibroids also supports the hypothesis of the existence of an interrelationship between ovarian follicle cysts, hyperplasia of the endometrium, and myomatous growths of the myometrium (Table II).

Even though both ovaries or the total ovarian tissue were available for study in only 50 per cent of the cases follicle cysts were found in every instance, while no mature

TABLE II.—ANALYSIS OF EIGHTY THREE CASES

Age in years	Cases
20 to 30	6
30 to 34	14
35 to 39	2
40 to 44	2
45 to 50	21
Total	83
Limits—27 and 50 years.	
9 women were over 50 years of age	
Married	70
Single	3
Fertile	42
Sterile	2
Miscarriage all in parous women	10
Undetermined from histories	6
Menstrual history	
Menorrhagia	68
Metrorrhagia	0
Dysmenorrhoea	11
Irritable	6
Thyroid involvement	
Family history of fibroids	3
Type of operation	
Hysterectomy	83
Bilateral salpingo-oophorectomy	33
Unilateral salpingo-oophorectomy	50
Condition of myometrium	
Fibroids	83
Hyperplastic	20
Fibrotic	17
Adenomyomatous	4
Carcinomatous	1
Sclerotic vessels	2
Metritic	2
Normal	35
Condition of endometrium	
Hyperplastic	83
Carcinomatous	1
Ovaries	
Both ovaries examined	33
All ovarian tissue examined	9
Only ovary examined	41
50.6 per cent of cases	
Condition of ovaries	
Follicle cysts	83
Corpus luteum	
Absent	73
Developing	0
Dermoid cyst	1
Carcinomatous	
Miscellaneous	
Salpingitis	33
Adhesions	48
Endometrial transplants	25†
97.6 per cent.	
73.0 per cent.	

corpus luteum was noted. Likewise, hyperplasia of the endometrium and fibroids of the

uterus were noted in every case. Again salpingitis and chronic inflammatory adhesions were found in 97.6 per cent of the patients while endometrial transplants were observed in 25 cases (30 per cent). While the 97.6 per cent of pelvic inflammatory disease offers a possible explanation for the follicle cyst formation and the subsequent ovarian dysfunction because of the disturbed blood supply to this organ the high percentage of endometriosis again suggests a possible etiological source from hyperplasia of the endometrium.

III The findings in a third group of 41 cases of fibroids and hyperplasia of the endometrium although the evidence is indirect since the ovaries were not available for study microscopically but were only commented upon grossly at the time of operation likewise support the hypothesis of a cause and effect relationship between hyperplasia of the endometrium, ovarian follicle cysts, and fibromyomata. However as noted previously if follicle cyst formation resulting in hyperestrin stimulation is accepted as the cause of hyperplasia of the endometrium the logical inference should follow that the findings of characteristic hyperplasia microscopically warrants the diagnosis of ovarian follicle cysts. Hysterectomy was performed in every case for multiple fibroids (Table III).

Hyperplasia of the endometrium was found in every instance. Likewise the operator commented upon the small ovarian cysts in each case. The operative observation of salpingitis

TABLE III

Condition of myometrium	Cases
Fibroids	41
Hyperplastic	6
Fibrotic	0
Adenomyomatous	1
Sclerotic vessels	3
Metritic	4
Endometrial transplants	3
Normal	18
Condition of endometrium	
Hyperplasia	41
Operative comment on ovaries	
Follicle cysts	41
Corpus luteum	
Salpingitis and adhesions	40
97.5 per cent.	

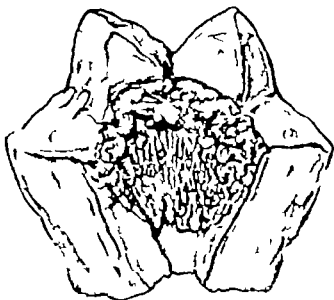


Fig. 1 Typical macroscopic hyperplasia of the endometrium.

and adhesions was made in 40 cases (97.5 per cent) again a very high figure

DEDUCTIONS

The evidence advanced by Schroeder Meyer Graves, Novak and Fluhmann is certainly sufficient to warrant the acceptance of a cause and effect relationship between hyperestrogen stimulation of the ovary and hyperplasia of the endometrium. Since the ovary reacts upon the uterus in its entirety and not just upon the endometrium some change in the myometrium should manifest itself from the unopposed action of estrin. One hundred and fifty cases of fibroids associated with ovarian follicle cyst formation and necessarily hyperestrogenism are offered to suggest a resulting fibromyomatous change in the myometrium, if the stimulation is prolonged sufficiently. If this be true that hyperestrogenism is the ignition so to speak of the fibromyoma, it does not follow that the hormonal stimulation has to persist after the growth is once present as proved frequently in our clinical experience in observing the combination of myomata and pregnancy. In such a condition we know the morphology of the endometrium is decidua and not the hyperplastic 'Swiss cheese pattern.' Whether the ovary is primarily responsible for the hyperestrogen production or not is an un-

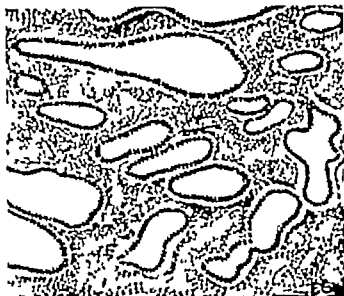


Fig. 2 Typical microscopic hyperplasia of the endometrium

settled question but in view of the newer knowledge of the motor hormone control by the anterior hypophysis it would seem more probable that the latter plays the important rôle especially since according to Novak the administration of its hormone can produce beneficial clinical results in functional uterine bleeding. Moreover it is contrary to the law of nature which maintains an external control over all organs or organisms that pass through a definite cyclic rhythm, that such an important organ as the ovary should maintain an intrinsic and automatic control over itself in having a beginning continuance and ending as shown by woman in her functional years. Yet it does not follow that if the ovarian function or rhythm is disturbed that the anterior hypophysis is always the cause. Any structure involved in the mechanism of its function might be at fault especially the blood supply as evidenced by the frequency of cystic degeneration of the ovary from disturbed nutrition after hysterectomy or salpinxgectomy.

Moench is of the opinion that the follicle cyst formation of the ovary is due to ovarian congestion and increased blood supply to these parts causing an increased number of follicles to ripen and not to an inflammatory process as formerly believed. This observer explains the presence of functional bleeding around the menopause as due to increased

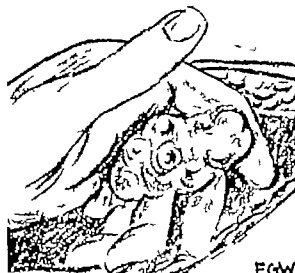


Fig. 3. Multiple follicle cysts of the ovary

pelvic congestion since women are heavier less active more constipated, and have perhaps lessened muscular tone. Favoring such an hypothesis Polak and Mazzola in experimental torsion of the vessels around the uterus parametrium and contiguous tissues, found marked hyperplasia and hypertrophy of all uterine layers. In addition there was a marked increase in the size and number of the blood vessels also the connective tissue ratio of the entire organ was greatly increased.

In accepting ovarian and uterine congestion as a cause of follicle cyst formation of the ovaries and myomatous growths of the myometrium, many findings are left unexplained, particularly the high incidence of fibroids in the negro race, the absence of fibroids during pregnancy when the uterus is most vascular and the non-development of fibroids in acute pelvic diseases and puerperal sepsis when the vascularity of the uterus and adjacent structures is highly increased.

I am inclined to believe that the cause of formation of follicle cysts of the ovary is not to be found in a passive congested state of these organs and adjacent tissues, but as previously discussed, in the disturbance of the blood supply to these parts. The most frequent occurrence of this follicle cystic change in the ovary is at the two extremes of woman's reproductive life at puberty the ovaries and

uterus undergo development in size and function with a natural increase in the blood supply. If this supply cannot keep pace, as it were with the anatomical and functional demands made upon it, naturally the organs must suffer from the insufficient blood supply and the results are possibly manifested in the ovaries by follicle cystic changes. At the other extreme the menopause, the reverse process occurs. The ovary has been passing through rhythmic monthly cycles, requiring variations of the blood supply to it and supplying the demands made upon it by the organism as a whole as the menopause approaches, the ovarian blood supply is curtailed as is seen in all other pelvic organs. If the blood supply becomes disturbed too quickly might not follicle cystic formation result before the natural senile inactivity of the ovary takes place?

The ovaries of negro women are being studied in an attempt to show that disturbed ovarian blood supply resulting from the high incidence of chronic pelvic inflammatory disease in this race, is the source of follicle cystic changes in the ovaries the findings will be presented in another communication. For the present I need only quote Miller who in 150 cases of fibroids in negroes, found tubo-ovarian disease in 93 per cent of the cases, and cystic degeneration of the ovaries in 80 per cent while Alsbrook, in 100 cases of fibroids in negroes, noted salpingitis in 99.1 per cent. In the present survey both chronic infections and adhesions were observed in over 95 per cent of the cases in addition to the follicle cyst formation and the ovarian stroma was considered atrophic, degenerative and fibrotic in an equally high percentage.

If as suggested by this paper there be a cause and effect relationship between ovarian follicle cyst formation resulting in immediate endometrial hyperplasia, and later in fibromyomatous growths of the myometrium the work of Novak and Hurd offers great therapeutic encouragement as a prophylaxis against fibroid formation. These observers have obtained cessation of bleeding in 44 of 51 cases of functional uterine hemorrhage by the administration of the anterior pituitary hormone and the restoration of the normal

menstrual rhythm seems apparent. If further study proves the result to be permanent it would seem legitimate to predict a decrease in the incidence of fibromyomatous growths in the white race through the prophylactic treatment of ovarian hyperestrinism with the luteinizing factor of the anterior hypophysis.

SUMMARY

1 The various theories pertaining to the histogenesis and etiology of fibromyomata of the uterus are discussed.

2 Evidence is offered to show that the unopposed action of estrin in the absence of the corpus luteum influence is the cause of hyperplasia of the endometrium.

3 An hypothesis is advanced to suggest that the unopposed action of estrin on the myometrium if prolonged sufficiently would result in fibromyomatous growths.

4 Twenty six cases of hyperplasia of the endometrium in which operation was done and diagnosis as such made from microscopic study and in which a second operation was performed for fibromyomata after an approximate interval of 4 years and 4 months are analyzed.

5 One hundred and twenty four cases of fibromyomata, diagnosed microscopically are offered with their associated ovarian and endometrial findings as presenting added evidence in support of a cause and effect relationship between ovarian follicle cystic formation hyperplasia of the endometrium and fibromyomata of the uterus.

6 An hypothetical conclusion is advanced that the unopposed action of estrin on the

uterus results (1) in immediate endometrial changes characterized by hyperplasia and (2) in more latent myometrial pathology in the nature of fibromyomatous growths.

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CLINICAL SURGERY

FROM DEPARTMENTS OF ANATOMY AND SURGERY UNIVERSITY OF NEBRASKA

REPAIR OF HIGH LACERATIONS OF THE RECTUM WITH COMPLETE INCONTINENCE

ANATOMICAL PRINCIPLES AND OPERATIVE TECHNIQUE

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IT is interesting to note the accomplishments and successes that follow the varied techniques in the treatment of lesions amenable to surgical therapeutics. In most instances the principles are the same the variation being in some of the details. I believe that when there is a choice, the simpler technique should be elected, provided reasoning and experience have proved that the more complicated procedure is unnecessary.

In a review of the literature on the technique used in repair of high lacerations of the rectum with complete incontinence, associated with third degree lacerations of the pelvic floor the methods of fourteen different operators were consulted. Eleven of these including Orr, Ristine, Noble, Tait, Ward, Emmet, Marcy, Goldspohn, Farrar, Kelly, and Crossen used silver wire silkworm gut, or kangaroo retention sutures, only three operators Titus, Watkins, and Clark repaired the perineum and sphincter and without the use of retention sutures. Despite the variance in this one principle of the technique, all of these authors claim equally good results. The first group who employ retention sutures usually of an unabsorbable nature incur the disadvantage of the necessary removal of the sutures some days later. Also retention sutures cause more discomfort to the patient.

During the last 3 years I have performed the operation six times by the simpler technique of avoiding retention sutures and all have been successful, including one operation which was carried out 12 years after the primary injury. Although very few authors report this operation without the use of retention sutures, I believe if the principles for attempting an anatomical restoration are followed with close adherence to careful operative technique and postoperative care, success is assured without the use of painful unabsorbable retention sutures which require removal.

The anatomy of the pelvic floor and its relation to the rectum and vagina have been well taught by Tandler, Halban, Edouard, Martin, Testut, and Jacob (Figs. 1 and 2). The principles of pelvic floor repair have been sponsored by Emmet, Tait, Marcy, Watkins, and Ward. The principles and methods of repair for high lacerations of the rectum were first introduced by J. Collins Warren in 1875. Ristine popularized this operation. Kelly initiated the individual suture of the sphincter and muscle. Of late Farrar has emphasized the use of this operation in extreme high lacerations of the rectum by dissection of the flap high on the posterior wall of the vagina just below the cervix.

The technique that is used in the repair of my cases is of the simpler type. In that no retention sutures are used. Over a period of 3 days prior to the operation the vagina and rectum are well prepared by twice daily irrigations of 1:5000 potassium permanganate. On the day previous to operation the patient is on a liquid diet and on the evening before operation is given a normal saline enema repeated until it returns clear. When the patient is brought to the operating room both the rectum and vagina are thoroughly irrigated with a quart of 1 per cent lysol solution. During this stage of the operation I prefer to wear two pairs of rubber gloves so that if it becomes necessary the index finger of the left hand may be inserted into the rectum to act as a guide. The flap is outlined as indicated in Figure 3, and if the tear reaches quite high on the rectal wall there should be no hesitation in extending it up to the level of the cervix. As indicated in the small diagram, care must be taken that the distance from *a* to *b* is slightly greater than from *b* to *c*; otherwise, the flap will be of insufficient length, and it is the vaginal surface of this flap which, when turned down, becomes the anterior surface of the lower rectum and anus. Care must also be

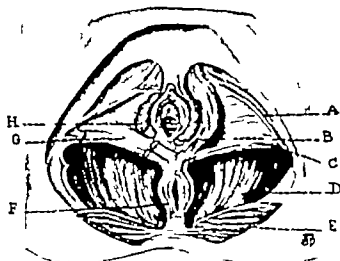


Fig. 1. Pelvic outlet exposed with removal of the skin, labia, subcutaneous fascia, superficial perineal fascia and contents of ischio-rectal fossae. *A* ischio-cavernosus *B* bulbocavernosus *C* superficial transverse perineal *D* levator ani *E* gluteus maximus *F* sphincter ani *G* urogenital diaphragm *H* Bartholin's gland (The superficial stratum *B* and *C* has been removed on the right side, thus exposing the middle stratum, urogenital diaphragm. The levator ani is considered the inner stratum.)

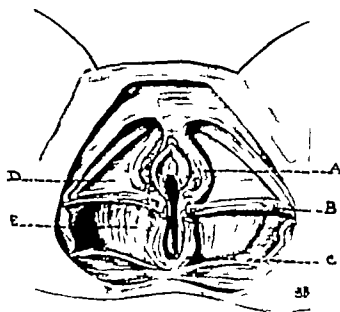


Fig. 2. There has been a complete laceration destroying the perineal body with the resulting separation of the bulbocavernosus muscle, the transverse perineal muscle, the sphincter ani muscle and the levator ani muscle. The vagina and rectum are now one cavity. *A* bulbocavernosus *B* transverse perineal *C* sphincter ani *D* urogenital diaphragm *E*, levator ani.

exercised not to buttonhole the rectum. The flap in the anal margin must extend lateral to the dimpled or palpable ends of the sphincter ani muscle. When it has been turned down as shown in Figure 4 the extra pair of gloves may be removed and at this time the operative area and the rectum should again be irrigated with 1 per cent lysol solution. From now on, rectal contamination is not probable.

After this flap has been turned down by either blunt or sharp dissection the levator ani muscles are found, particular care being taken to pick up these muscles far back from the introitus because the firmer and more accurate approximation that is made of the levator ani muscles and fascias around the rectum, the more they act as accessory muscles in sphincter control. Although simple interrupted sutures of No. 2 chromic catgut may be used, I prefer to use interrupted No. 2 chromic catgut figure-of-eight sutures to approximate the edges of the levator ani muscle. Usually about three sutures are necessary. This builds up a very good muscular wall separating the vagina and rectum and helps cover over the flap of vaginal mucous membrane which has been turned down to form the anterior wall of the rectum. As shown in Figure 5 several interrupted No. 1 chromic catgut sutures are then used to close the upper end

of the vaginal exposed area by bringing together the edges of the mucous membrane and the margins of the urogenital diaphragm. This bringing together of the levator ani muscles holds the rectum somewhat forward and serves as a splint to the perineum for the repair of the sphincter muscle and the transverse perineal muscles. Both the superficial and deep transverse perineal muscles have been lacerated in the complete tear and approximation of these further strengthens the former central point of the perineum. Sometimes there is considerable difficulty in locating the ends of the transverse perineal muscles. These muscles just mentioned are usually sutured with No. 1 chromic catgut figure-of-eight sutures both ends being brought to the central point anterior to the rectum. Careful search is then made for the ends of the sphincter ani. When the ends have been located care must be taken not to isolate them too freely or more retraction is likely to take place and with fascia removed the sutures to be placed have less likelihood of holding. This surrounding scarred and fibrous tissue tends to splint the muscle and hold it in fairly good position. The ends are brought together by a No. 0 chromic catgut figure-of-eight suture and this suture in turn picks up a bite of muscular and fascial tissue in the newly made central point of the perineum (Fig. 6). An interrupted No. 1 chromic catgut suture closes Colles' fascia and brings the skin margins together

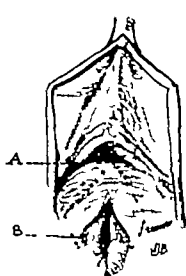


Fig. 3

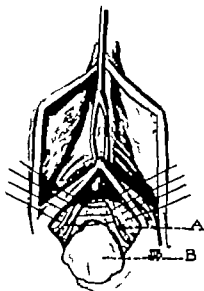


Fig. 4

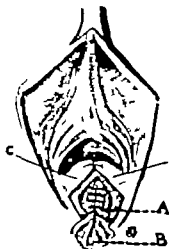


Fig. 5



Fig. 6



Fig. 7

Fig. 3. Large cut. Outline of incision to be made into the mucous membrane of the vagina. Dissection is carried downward from point *A*. The margin of this flap must be outside of points *B* which usually indicate by small depressions or by palpation the ends of the lacerated sphincter and muscles. Small cut. The length of the flap from *a* to *b* which is the top of the laceration, must be as great or greater than, the distance from *b* to *c*. The mucosa of this flap when turned down faces the rectum and anus. Points *a* must be outside of the sphincter ends, *sp*.

Fig. 4. The flap *B* has been turned down and the levator and muscles, exposed. Interrupted No. 2 chromic catgut sutures have been placed. This bridges over with

muscle and fascia the defect present between the anus and rectum.

Fig. 5. The levator and sutures have been tied. One suture in the mucosa has been tied and one is in place. The suture marked *C* is interrupted chromic catgut and must grasp the mucous membrane, and the turn edge of the urogenital diaphragm.

Fig. 6. *A* Suture grasping the transverse perineal muscles; *B* suture grasping the ends of the sphincter and muscle.

Fig. 7. The mucosa and fascia have been closed with interrupted chromic sutures. *A* Final puckering suture through flap and skin edges.

subcutaneously. A small purse string suture of No. 0 chromic catgut takes up the excess tissue of the flap and slightly puckers it around the anterior margin of the anus (Fig 7). The operation is then completed by injecting 1 to 2 ounces of sterile vaseline into the rectum. This tends to act as a mold and as a protective dressing for the lower rectum and anus. However its principal function is to serve as an effective lubricant at the time of the first bowel evacuation after operation.

The after-care of these patients is most important. The perineum must be kept clean by repeated external douches of 1:5000 potassium permanganate solution after each urination or bowel movement, in any event the douches should be given twice a day. The thighs must be kept together. The patient should be on a liquid diet without milk for 5 days and then on a soft diet for 5 days. Bowel evacuation is stimulated on the fifth day by giving citrate of magnesia. At no time are enemas given and after the fifth day constipation is prevented by giving petrololagur twice daily and a small dose of citrate of magnesia every other day if necessary. About the tenth day rectal examination is made at first introducing only the little finger. This should be repeated every 2 or 3 days in order to prevent any stricture formation.

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Fig 8 left. Rectum and vagina may be seen having one common external opening. No perineal body present. Photograph of Case 3.

Fig 9. Same patient 2 weeks after operation showing a strong perineal body with considerable tissue between the anus and vagina.

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ARRHENOBLASTOMA OF THE OVARY¹

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We are indebted to Meyer for calling our attention to the rather novel conception that tumors have function much as any normal organ. This fact is ordinarily overlooked, although the cachexia associated with malignant disease has been noted for centuries. The best example of neoplastic function occurs in the ovary, which is the site of certain unusual tumors, notably the granulosa cell carcinomata whose secretions produce an exaggerated femininity as evidenced by precocity of sexual development in the young subject and rejuvenation in the old and some of the arrhenoblastomata whose hormones not only defeminize, but masculinize their hosts. The term arrhenoblastoma (meaning to make like a male) as proposed by Meyer to cover this interesting group of masculinizing tumors of the ovary numbering 26 in the literature today, is restricted to those tumors which show male characteristics histologically as well as clinically, and furthermore excludes those cases of ovario-testis or true hermaphroditism.

This case is being reported not only as an example of this extremely rare condition, but in order to illustrate the powerful influence exerted by sex hormones, both normal and abnormal, upon the development of the secondary sexual characteristics of the body.

REPORT OF CASE

One of us (J. M. T.) was called to see Miss M. E., Case N. 32-33, a white school girl, 18 years old, who entered St. Edward Mercy Hospital January 30, 1935, complaining of severe abdominal pain, cough, fever and pain in the chest. The family history was irrelevant except that both parents were born in Germany.

The past history was negative except for the extremely interesting story concerning the reproductive system. She began menstruating at the age of 3 years, with a regular interval of 35 days, moderate flow without pain, lasting 4 to 6 days. At the age of 14 years the menstrual periods suddenly ceased and patient has not menstruated since that time. At the age of 6 years she noticed the development of excessive hair on the face and over the body which was progressive to the extent that it was necessary to shave the face with increasing frequency. A change was also noted at this time in the voice, it at first becoming coarse, then developing a contralto quality and reaching the present stage of a very definite baritone.

The onset of the present illness occurred about 1 month previously when she noted pain in the lower part of the abdomen with progressive enlargement. A few days before admission she developed a cough, followed by pain in the chest, fever and the expectoration of blood tinged sputum.

Physical examination at the time of admission showed a very sick young white girl who was mentally alert, clear

and co-operative. The appearance of the face with bushy eye-brows and marked beard, was very striking, and suggested that of a young man. The hair of the head, while short, was rather profuse. The temperature was 104 degrees orally, the pulse rate 158, and the respiratory rate 58. The blood pressure was 105/60. There seemed to be an excessive pallor to the skin and mucous membranes. The patient was coughing incessantly and at three expectorating blood tinged sputum. Dullness, approaching flatness, with suppressed breath sounds, was found over the entire posterior aspect of the left lung, with numerous coarse rales over the upper portion. The right lung was clear. The breasts were flat and atrophic. The nipples were coarse, pigmented, and a circle of long hair was present in the areola. No abnormalities were noted about the heart. There was a marked generalized hypertrichosis, especially noticeable in the axillae, forearms, inside the thighs, and around the perineum. The distribution of the pubic hair was of the masculine type with a heavy ridge in the midline extending up to and around the umbilicus. The abdomen was enlarged in the lower half due to an abdominal tumor the size of a 6 months' uterine pregnancy and extending down into the pelvis. Tenderness in the left lower quadrant was so exquisite that the patient could hardly bear the weight of the bed covers on her abdomen. On vaginal examination the clitoris was found to be hypertrophied to three times normal size, with well developed prepuce, the hymen absent, and the vaginal canal contracted so as to admit only finger with difficulty. The cervix was small, soft, and the uterus could not be outlined. Motion was not communicated to the cervix by moving the tumor from above the symphysis. The mass could be felt partially distending the cul-de-sac and lateral fornices.

A markedly flat masculine type of pelvis with masculine type of skeleton was shown by the following measurements of pelvis and shoulders: Pelvis—spines 23.5 centimeters, crests 24 centimeters, trochanters 26 centimeters, external conjugate 15 centimeters, and ischial tuberosities 8 centimeters, shoulders—36 centimeters.

Clinical laboratory studies gave the following results. Blood examination showed erythrocytes 3,000,000 hemoglobin 60 per cent, leucocytes 7,000 differential—Schilling count—juvenile cells, 21; staff cells, 17; segmented cells, 68; lymphocytes, 16; eosinophiles 0. Shift to the left so nuclear index 3½ malaria negative Wassermann negative.

Urinalysis, no 8 acid trace albumin, no sugar few unclumped white cells.

X-ray report by Doctor W. R. Brookshier, Jr., abdomen, large dense abdominal and pelvic tumor head, normal sella turcica chest, massive pleural effusion, left side.

Patient continued to vomit frequently and the abdominal pain persisted. Temperature remained elevated to 100 degrees, with the rapid respiratory rate persisting. On February 14, 1935, 2,800 cubic centimeters of dark bile colored fluid were aspirated from the left pleural space following which there was considerable improvement in her general condition. This fluid was negative on culture and negative for tubercle bacilli by 6 weeks guinea pig inoculation and autopsy.

The pleural fluid continued to reform. At thoracentesis was performed 7 times, 1800 to 2500 cubic centimeters of fluid being removed at each sitting. The abdomen con-



Fig. 1 Appearance of face with well developed beard and moustache. Note bushy eyebrows.

tinued to be exquisitely tender and in spite of the fact that patient was retaining some nourishment, she continued to lose ground. Operation had been deferred because of the pleural effusion and poor physical condition but by April 14, 1932 the tumor had enlarged to the size of a full term pregnancy and pressure symptoms were of such severity that surgical intervention was deemed imperative.

A pre-operative diagnosis was made as follows: (1) teratoma of the ovary with a preponderance of functioning testicular tissue. (2) the possibility of true hermaphroditism, with destruction of the ovarian tissue by neoplasm probably malignant, and functioning of the testicular tissue, was also considered.

On April 14, 1932, under spinal anesthesia, administered by Dr. M. E. Foster laparotomy was performed by two of us. (Drs. J. M. T. and S. J. W.)

Operation. A low midline incision was made and when the peritoneal cavity was opened approximately 3,000 cubic centimeters of thin brownish fluid escaped. The tumor was found to be semicystic, and of the size of a full term pregnancy extending from the pelvis to the xiphoid process of the sternum. Since it could not be delivered through the incision, which was extended 4 centimeters above the umbilicus, the volume was somewhat reduced by aspirating 4,000 cubic centimeters of thin brown fluid from several cysts. Adhesions to the liver and viscera of the upper portion of the abdomen were broken up and the tumor was delivered. It was then found to be an intraligamentary tumor arising from the region of the left ovary and was removed by dissection from the leaves of the broad ligament and ligation of the pedicle. Raw areas were well peritonized. The right ovary was smooth, brown, half the usual size, and did not show the slightest evidence of formation of graafian follicles or corpora lutea. Both tubes were normal. The uterus was one third the usual size, and apparently otherwise normal. The wound was closed in layers without drainage and the patient returned to her room in good condition.

The convalescence was extremely smooth and it was a notable fact that there was no further recurrence of the pleural effusion. X-ray examination failed to demonstrate chest metastases. The appetite and strength rapidly returned and she was discharged from the hospital greatly improved in good condition May 10, 1932.

A decided change in the appearance of the patient was soon noted. Menstruation occurred for the first time in 4



Fig. 2 Full view of body showing hypertrichosis, masculine pelvis, and male type of skeleton.

years on May 22, 1932. It has occurred regularly at 4 week intervals and 3 to 5 days duration since this time. A normal feminine type of voice was noted July 24, 1932. At the present time September 30, 1932 the patient has gained 40 pounds in weight, a marked hypertrophy of the breasts has taken place and the normal feminine habitus has been resumed. The clitoris and prepuce are less prominent. An abnormal growth of hair is still apparent over the chin but it is of a much finer texture and of lighter color. The patient now shaves once in 5 weeks instead of every 3 to 4 days, as formerly.

Gross pathology. A great portion of the weight and volume of the tumor had been lost due to evacuation of multiple cysts. After removal the tumor measured 20 by 20 by 18 centimeters. The weight was 900 grams. The tumor grossly resembled the ordinary multifollicular serous cystadenoma. There was a well developed fibrous capsule which had not been broken through and was smooth for the most part except at the uppermost portion which had been adherent to the liver. Large tortuous blood vessels were visible through the capsule. The pedicle was broad and vascular. On section some of the cysts were found to contain masses of soft greyish, friable material. The solid portion of the tumor had the consistency of a normal ovary although ovarian tissue as such could not be recognized. Unruptured cysts contained thin brown fluid.

Microscopic pathology. Sections were cut from many different portions of the tumor and show two distinct types of morphology each of which is undergoing degeneration on one hand and active proliferation on the other. The bulk of the tumor is made up of an atypical arrangement of small round and spindle cells, showing an occasional whorl and a suggestion of groups being bound together in fasciculi. The majority of the nuclei are oval to round irregular in size, and for the most part hyperchromatic. Mitotic figures are common. A few of the nuclei are pale large and filled with dark granules. In the more cellular portions of the tumor there is no evidence of stroma. A rich network of thin walled, poorly constructed capillaries is generally present.

Some areas of the tumor show a well marked coagulation necrosis and infiltration by small lymphocytes. Other areas give evidence of hemorrhage, and in some fields hyaline degeneration. Where a stroma is present, it consists of an edematous, fibrillated, white connective tissue.

The cyst walls consist of loosely arranged white fibrous connective tissue rather deficient in nuclei, very vascular, and in some areas invaded by an entirely different type of cell which is epithelioid, filled with lipid, and can be identified as an interstitial cell. Figure 8 depicts these cells. There is no epithelial lining to the cysts. It may be conjectured that they have arisen as the end-result of coagulation and liquefaction necrosis of portions of the tumor.

Other blocks show the structure to be undoubtedly epithelial as illustrated in Figure 7. This tissue came presumably from the region of the hilum of the ovary and



Fig. 3. Contracture of vagina and hypertrophy of clitoris. Prepuce well developed.

represents the primary growth. The cells are arranged in the form of irregular medullary cords (Fig. 7) and also as rudimentary tubules (Figs. 5 and 6). As shown the tubules are lined with a single layer of typical columnar to cuboidal epithelium without basement membrane. Cellular detritus and coagulated material have collected in some of the lumens, and in a few definite pear-shaped forms, suggesting typical spermatozoa, can be made out. Such an intima is clearly shown in the lower right hand corner of Fig. 6.

Another special significance is the resemblance of many of the intervening cells as pointed out by Novak, to a rounded and hyperplastic rete ovarii structure.

It is therefore our contention that this tumor is primarily an epithelial tumor originating in the hilum of the ovary, and developing from anlagen in the rete consisting of residual undifferentiated cells which have developed along male lines as evidenced by the presence of tubules similar to seminiferous tubules and of typical testicular interstitial cells. This histological evidence is the link of proof needed to stamp this tumor as an arrhenoblastoma primarily which has undergone secondary sarcomatous degeneration.

INCIDENCE

There are no reliable figures on record as to the incidence of this rare tumor. At the present writing of the 26 reported cases none has occurred in the United States. Other cases have occurred, as an undoubted case of Casler's, but have not been reported. Since Meyer's illuminating work additional cases will undoubtedly be added with increasing frequency. The tumor occurs chiefly between the age limits of 21 and 35 years.

SYMPTOMS

1. *Defeminization*. The earliest sign has usually been a persistent amenorrhea with sterility. There is a tendency for the hair of the head to fall out and be short. The breasts atrophy and abnormal deposits of fat may occur over the body. The genitalia of the individual are hypoplastic with the exception of the clitoris. The vaginal



Fig. 4. Gross appearance of tumor

canal is short and contracted, the body of the uterus and cervix atrophic or infantile and the opposite ovary small and entirely free from graafian follicles. The libido has been unchanged until late in the disease.

2. *Masculinization*. The skin is usually dark, rough, and shows a tendency to an acne eruption. There is an abnormal and excessive development of hair over the body. A beard, necessitating in some cases daily shaving is usually present. The distribution of hair over the pubis is of the masculine type. Hair may be present around the nipples. The facial expression is masculine, due to the coarse features and bushy eyebrows. There is an enlargement of the larynx, resulting in a lowering of the pitch of the voice. The skeleton is heavy and there is an inversion of the normal "pelvis to shoulders ratio" of the female. The musculature is correspondingly affected. The clitoris is hypertrophied in most long standing cases.

3. *Pain*. This symptom is usually present because of the pressure produced by a rapidly growing pelvic tumor. This pain may be constant or aggravated by micturition or defecation.

4. *Blood changes*. Secondary anemia is usually present and an increase in eosinophiles and monocytes has been noted. The temperature is frequently elevated. The Aschheim-Zondek test is negative.

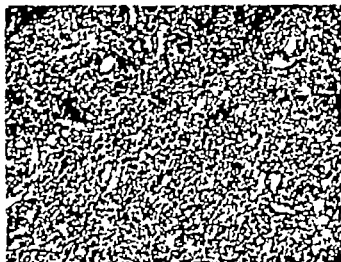


Fig. 5. Photomicrograph showing the tubules as they appeared under low power magnification.

5 A restoration of the normal female characteristics occurs after removal of the tumor with remasculinization upon recurrence. Normal pregnancy has occurred after operation in a number of the reported cases.

DIAGNOSIS

The association of a growing pelvic tumor with amenorrhea naturally suggests pregnancy which has been the usual tentative diagnosis made in these cases. The coarsening of the features indicative of beginning masculinization also may be interpreted as the normal accompaniment of pregnancy. However the Aschheim Zondek test will absolutely differentiate the two. The de-



Fig. 6. High power magnification showing structure of tubules. Note pear shaped form in the lumen of one tubule.

feminization and development of outspoken masculine characteristics, in an individual previously normal under the above conditions should certainly suggest this tumor clinically. The finding of evidence of rudimentary testicular cells in the tumor microscopically confirms the diagnosis.

TREATMENT

The treatment is extirpation of the tumor without disturbing the remaining pelvic organs, since one ovary is all that is affected and retention of the secretion of the other is essential to effect return to the normal feminine state. With the present state of our knowledge and for the same reason as above prophylactic deep X ray therapy



Fig. 7. High power photomicrograph showing the irregular epithelial cord-like structure. (Courtesy of Dr Robert Meyer)



Fig. 8. Lipoid-containing epithelial cells found in periphery and in stroma of tumor. These are interstitial cells. (Courtesy of Dr Robert Meyer)



Fig. 9. Five months after operation. Note marked hypertrophy of breasts, return to feminine contour of hips and thighs, lessened hypertrichosis. Weight gain, 40 pounds. Compare with Figure 2.

does not seem to be indicated. In the event of recurrence deep X-ray therapy should be of value because of the marked sensitivity of germinal epithelium to destruction by radiation.

PATHOLOGY

As a rule the arrhenoblastomata show marked cystic degeneration so that often solid portions may be very sparse. A number of cases of masculinizing tumors of the ovary previously reported as sarcomata or multilocular cystadenomata may fall into this classification after re-study. This is particularly true of the group in which the signs of masculinization have not been outspoken clinically. Histologically there appear to be three distinct groups according to Meyer.

1. *Idenoma testiculare*. Nine of the reported cases fall into this group. The structure is very similar to the tumor of the same name occurring in the testis, and is predominantly tubular. Masculinization clinically is the exception rather than the rule.

2. *Atypical group*. The 11 cases falling in this group showed marked masculinization in 9 instances. The case here reported is an additional instance. The structure is sarcoma like and the tubules often rudimentary.

3. *Intermediate group*. In all 6 cases collected by Meyer masculine changes of a slighter degree were present. Morphologically these tumors resemble group 1 in some areas and group 2 in others.

With the present state of our knowledge concerning sex differentiation, Meyer's theory of the origin of these tumors from undifferentiated germ cells in the hilum of the ovary which have not been utilized during embryonic development of the ovary but which have retained their sexual

potency and remained dormant until some such time when for an undetermined reason proliferation takes place, is most compatible. Pick's theory that these tumors develop from an ovarotestis is not tenable in view of the fact that these patients do not exhibit evidence of bisexuality from birth and that true hermaphrodites have never been known to develop tumors which defeminize and masculinize.

It is an interesting speculation why the most marked changes toward masculinity occur in the atypical group with sarcoma like structure. Those tumors in which the tubular arrangement is best developed are rarely associated with alterations in the secondary sexual characteristics of the individual, and in true seminomata, practically never. In the instance here reported, the sarcomatous appearance almost completely masks the tubular structure, although clinically extreme masculinization had occurred and return to femininity is in progress after extirpation of the tumor. Meyer is of the opinion that under certain conditions a transition is possible from epithelial to connective tissue. It has been assumed that the endocrine secretion of the testis, and presumably also the hormone affecting the secondary sexual characteristics of the body is a product of the interstitial cells of Leydig, which exist under normal conditions in the form of irregular cords and which cannot be distinguished histologically as epithelial or mesodermal, although embryologically the bulk of the evidence is in favor of origin from the latter. It is the opinion of one of us (F. K.) that possibly an excessive amount of this hormone is produced by this hyperplasia of residual undifferentiated cells with definite male tendencies in the hilum of the ovary or in other words a hyperplasia of anlagen of Leydig's cells, and that the tubular formation is merely another form of expression of tumor function and of the underlying tendency toward masculinity. Since normally interstitial cells cannot be classified exactly from the standpoint of tissue groups, it is tenable that under abnormal conditions this confusion should be even greater. Meyer has also suggested the possibility of a secondary sarcomatous degeneration of the stroma of the tumor.

In this particular case, recurrence will undoubtedly take place, since the removal was necessarily incomplete because of adhesions to the liver. Light may be shed upon this question by a study of the morphology of the recurrence. It must be emphasized however that while primary ovarian sarcomata are not uncommonly seen, masculinizing changes associated with such tumors only occur where epithelial elements

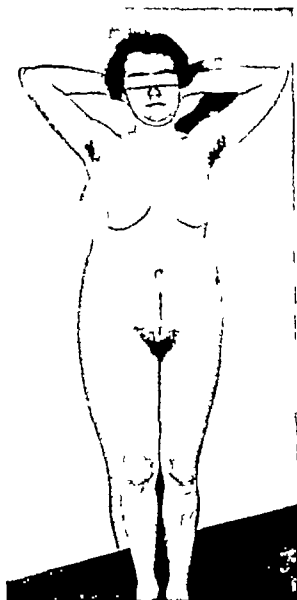


Fig. 10. Five months after operation. 40 pounds weight gain; return to general body type of feminine contour.

having the histological structure described by Meyer under the term arrhenoblastoma are present.

PROGNOSIS

These tumors are predominantly malignant. In the 8 cases reported up to 1909, only 1 was malignant. In 13 cases collected by Strassman since this time, all have been malignant except one. The case here reported shows malignant degeneration. This malignancy, however, is usually relatively benign as recurrence and metastases do not usually make their appearance before 6 to 7 years.

SUMMARY

This case of arrhenoblastoma of the ovary is reported as the first case from the United States,



Fig. 11. Compare with Figure 1. Five months after operation. Lessened hair growth, of finer texture. This growth of beard of 5 weeks duration. Figure 1 of 4 days.

and the twenty seventh in the literature in order to call attention to this condition which if generally appreciated and recognized would offer an exceedingly fertile field for increasing our knowledge of endocrinology by means of animal experimentation with tumor transplants, extracts and transudates.

NOTE.—The authors wish to express their indebtedness to Dr. Emil Novak, of Baltimore, Md., for his valuable suggestions to Dr. J. L. Goforth of Dallas, Texas, for the histological sections which made this study possible and for the preparation of part of the photomicrographs and to Professor Robert Meyer of Berlin, Germany, for his study of the tumor and photomicrographs.

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TREATMENT OF FRACTURES OF THE BONES OF THE LEG

JAMES WILLIAM MARTIN, M.D., F.A.C.S., OMAHA, NEBRASKA

CURRENT surgical literature is so full of articles dealing with the use of skeletal traction in the treatment of fractures that any further contribution along this line might be promptly regarded as superfluous. The writer is emboldened to submit this paper dealing specifically with treatment of fractures of the bones of the leg because of the conviction that the technique to be described has both simplicity and dependability to recommend it.

Those who have had wide experience in treating fractures will readily agree that fractures of both bones of the leg often present an especially troublesome surgical problem. The fact that many of these fractures are compound adds, of course, to the difficulties. Whichever the type of fracture that is, simple or compound, extensive injury to the soft parts and serious disturbance of the local circulation about the ends of the fractures are frequent accompaniments. One need reflect but a moment upon the incidence of delayed or non union in these fractures to agree with this state

ment. When the position of fragments approximates anatomical perfection and there is no local infection or general constitutional factor to explain the failure of prompt union there can be only one cause of delayed union, namely a disturbance in the local physiology induced by tissue and particularly minute blood vessel trauma. Any reduction procedure which adds more traumatism to the fracture site is physiologically wrong and should be avoided.

Obviously the procedure which adds the greatest burden to the already embarrassed local physiology is open reduction and direct internal fixation with non absorbable material. This does not mean that open reduction and fixation with metal will invariably be followed by failure; common experience disproves that this is a universal truth. But the implication is that this method will inevitably show a rather high percentage of poor results in terms of delayed or absolute non union inasmuch as it is inimical to the normal healing process.



Fig. 1 After the skeletal traction device, either Steinmann or Kirschner type, is in place the knee is flexed over the upper cross bar of the frame and the traction bow is hooked onto the turnbuckle. (The frame is made of half inch pipe except for the upper sliding unit which is one quarter inch.)

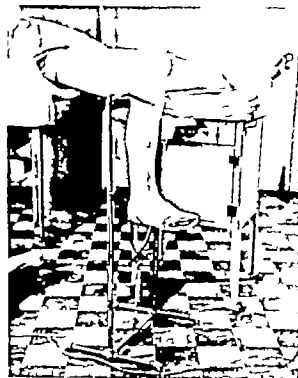


Fig. 2 The upper cross bar is pulled up as far as possible depending upon the length of the particular leg, and it is held in place by inserting the keys (seen here attached to the small chain). It will be noted that there is ample room for application of the cast.

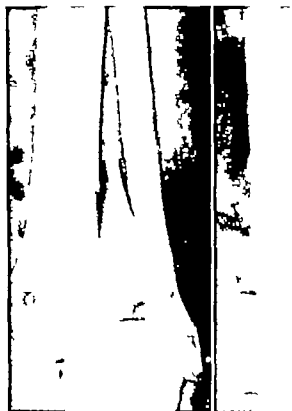


Fig. 3

Fig. 3. Case. Compound comminuted T fracture of tibia extending into ankle joint, and simple transverse fracture of fibula. Patient a male aged 35 years.



Fig. 4

Fig. 5

traction on frame and fixation in plaster. Note distraction or overpulling of tibial fracture.

Fig. 5. Case 1. Correction of overpulling and angulation by removal of section from cast.

There can be little justification for the internal metal fixation method in these leg fractures if it is quite uniformly possible to effect by means of the closed method an approximately anatomical reposition of fragments. It is the purpose of this paper to describe a technique of closed reduction in fractures of the bones of the leg which does insure this desideratum.

TECHNIQUE

This technique is simply the application of traction in an efficient completely controllable manner followed by fixation in such a fashion that the correction or reduction of the displaced fragments is maintained with accuracy and permanency. Traction applied by the operator tugging with his unaided hands on the foot of the patient while an assistant vainly tries to exert countertraction on the knee, thigh, or crotch is not efficient traction because though reduction may be momentarily obtained, it cannot be

maintained during the application of the fixation apparatus whether cast or splint. Traction applied on a fracture table through adhesive tape and moleskin stuck on the skin of the leg is very frequently not efficient traction, particularly when fractures are situated low in the shafts. Traction to be efficient in these fractures must be skeletal traction. It must be employed in such a way that reduction will be obtained immediately so that definitive fixation of the fragments may take place immediately. Nature does not wait 2 or 3 weeks or any other period before starting the work of healing. The "stimulus of incompleteness" exerts its influence at once. A skeletal traction technique which carries out gradual reduction by weight and pulley over a period of several hours or days is prone to too many accidents. It frequently does not give the operator the complete accurate, mechanical control of the situation which he should have and in addition it may be distressing to the patient.

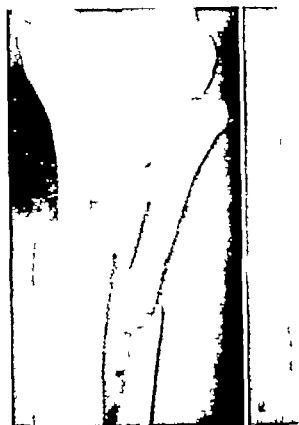


Fig 6

Fig. 6 Case 2 Anteroposterior roentgenogram taken before reduction



Fig 7

Fig. 7 Case 2 Anteroposterior view after reduction.



Fig 8

Fig. 8. Case 2 Lateral view after reduction.

The mechanical requirements of reduction and fixation are well met in the following technique:

1. A skeletal traction device either Steinmann pin or Kirschner wire is inserted through the calcaneus or just above it. Placing the pin or wire completely through the bone is preferable because it gives more certain control of the rotation of the distal fragments. (In some instances tongs inserted into the malleoli are preferable e.g. when a fracture of the calcaneus is present in addition to the tibial and fibular fractures.) If the Steinmann pin is used, the unjointed pin and not the type that screws together in the middle should be selected. The latter breaks too readily.

2. The patient is next moved down on the table so that his buttocks are opposite the lower edge of the table and his knee on the injured side is flexed to a right angle over the upper cross bar of the frame. The uninjured leg may be supported on another stand.

3. The Kirschner wire or Steinmann pin device is next attached to the turnbuckle fastened to the lower cross bar of the frame.

4. The adjustable upper cross bar of the frame is next pulled up as far as possible (depending

upon the length of the leg) carrying the flexed knee with it and the keys are inserted into the uprights to hold the cross bar in place.

5. Further traction is then obtained by twisting the turnbuckle until the fragments are pulled into place. Frequently reduction is perceived by the hand applied to the sides of the leg at the fracture level. A further check on length is had by comparing the measurements from the knee joint line to the tip of the internal malleolus on both legs in corresponding positions. And finally roentgenograms of the leg are made in the anteroposterior and lateral positions. A portable unit being wheeled into the operating room for this purpose.

6. While the films are being developed application of a plaster cast is begun with the knee in right angle flexion and traction still maintained. Molded splints are used as the foundation for the cast and the cast is fashioned in sections above and below the line of fracture. (No plaster is wrapped around the upper cross bar of the frame in order that the leg may be eventually lifted off the frame without difficulty.) By the time the upper and lower segments of the cast are finished the roentgenograms have been developed

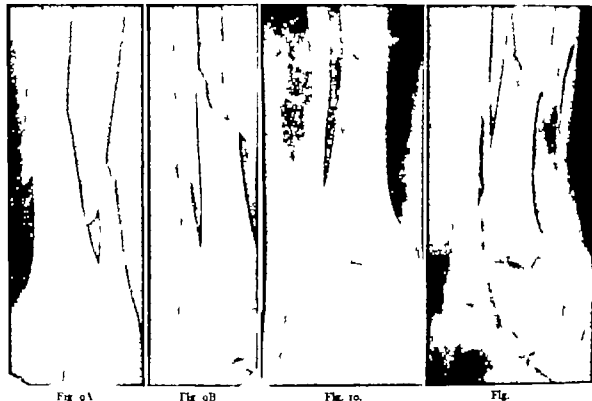


Fig. 9A

Fig. 9B

Fig. 10.

Fig.

Fig. 9. Case 3. Anteroposterior and lateral views before reduction.

Fig. 10. Case 3. Anteroposterior view after reduction.

Fig. 11. Case 3. Lateral view after reduction.

and are available for examination. Any further correction of the position of fragments which is indicated is easily obtained and the two segments of the cast are joined together with a few additional turns of the plaster bandage. The pin or wire is removed from the heel as soon as the cast has hardened unless the fracture is severely comminuted in which case there may later develop a further need for skeletal traction as will be mentioned later. The hiatus in the cast at the back of the knee found when the leg is lifted off the frame is filled in with a short molded plaster splint and a few circular turns of plaster bandage.

7 As soon as the cast is completed, it is slit or cut through its entire length, usually on its external lateral side to lessen circulatory interference. This is a very important step and should never be omitted. The cast is prevented from becoming too loose by encircling it in three or four places with webbing straps or simple adhesive tape.

Reduction is, of course, performed under general inhalation or spinal anesthesia. In my experience the latter is much better because it gives such complete muscle relaxation.

If the surgeon is so situated that immediate X-ray examination during the reduction procedure is not available measurements and the gross appearance of the limb must be relied upon, and the cast completed at once. In this case the wire or pin is left in the heel and check up roentgenograms are made some hours later or on the following day. If these films reveal the need for further traction or correction of angulation deformity the plaster cast, provided it has been carefully applied affords the mechanism for complete correction. If the fragments are end to end but in faulty alignment the cast is cut through for about three fourths of its circumference at the level of the angulation deformity, the angulation is easily corrected without anesthesia and the corrected position is maintained by a few turns of plaster bandage re-inforcing the plaster cast. If further traction is needed the cast is cut through its entire circumference at the level of the fracture traction is again applied to the heel pin sufficient to correct the shortening, and finally the proximal and distal portions of the cast are joined together with molded strips and a few turns of plaster bandage. Conversely if the fragments have been over

pulled a ring of plaster of the proper width is removed from the cast at the level of the fracture and the two segments again fastened together with plaster

POST REDUCTION TREATMENT

There is no need for haste in removing the pin from the heel, but similarly there is no point in leaving it in place after it has served its purpose. In simple fractures the pin is removed as soon as the check up roentgenograms reveal no need for further traction. In compound fractures the time for removal of the pin depends upon the absence or presence of frank infection in the fracture wound. If no infection has developed at the fracture site by the end of the first week it is concluded that there will be no further need for the pin and it is removed. If during this period infection extensive enough to require removal of the cast has occurred the pin is left in place and utilized during subsequent treatment of the injured limb in a Thomas splint.

The thigh portion of the plaster cast is discarded about the end of the fourth week to permit mobilization of the knee and at this time a walking iron is fastened to the leg cast with a few turns of plaster bandage. The walking iron should be applied with care or it will prove more of a hindrance than an advantage. The long axis of the iron should coincide with the long axis of the leg and the iron should extend not more than 2 or 2.5 inches below the cast, it being assumed that the foot has been correctly placed at a right angle with the leg. The sole and heel of the shoe on the uninjured foot usually need to be elevated a little to equalize the length. Weight bearing is now freely permitted first with crutches until the weakened quadriceps femoris muscle has regained some strength and then with a cane. The cast is usually completely discarded about the tenth week in the severer fractures. The criterion of course is the roentgenological and clinical evidence of union. The period of total disability should not exceed 14 weeks in a patient employed at heavy common labor provided there has been no infection or other complication.

SELECTION OF CASES

This technique of immediate reduction by means of skeletal traction on the specially constructed frame followed by immediate fixation in plaster is applicable to practically all fractures of the shafts of the tibia and fibula with considerable displacement whether simple or compound. In compound fractures débridement is sparingly performed, only the skin edges and the frankly

devitalized muscle tissue being excised. The wound is packed with vaselized gauze and no attempt is made to bring the skin edges together though a few silkworm sutures are inserted chiefly to control oozing. Copious dressings are then laid over the wound and bandaged in place after which the pin or wire is inserted into the heel just as in a simple closed fracture. No window is cut in the cast and the compound fracture wound is not dressed as long as the patient's temperature does not become alarming. If frank infection does develop it is of course treated according to common surgical principles.

ADVANTAGES OF THE TRACTION FRAME

The chief advantage of the traction frame over the standard fracture tables in the treatment of the fractures here under consideration is that it permits traction on the leg with the knee flexed to 90 degrees with a minimum of bother and a maximum of control. And there can be no difference of opinion regarding the preferable position of the knee during reduction of these fractures: the right angle flexion position is by far the better. It is better than the extended position because it gives additional relaxation to the calf group of muscles because it affords a perfectly fixed point of countertraction and because it renders redislocation of the reduced fragments after application of the cast impossible. I think this particular frame has perhaps some advantages over the apparatus used by Boehler inasmuch as angulation at the site of the fracture is less likely to occur with the leg in the dependent or vertical position than it is with the leg in the horizontal position; furthermore this frame interferes less with application of the plaster cast and finally it is simpler to construct. Other advantages of the frame besides its efficiency are its inexpensiveness and portability. It may be used for fractures other than those of the tibia and fibula though this does not come within the scope of this paper.

SUMMARY

1. Open reduction and internal fixation by means of non-absorbable material in fractures of the bones of the leg is too frequently followed by delayed or non-union.

2. Closed reduction will give a high percentage of good results in terms of shortened convalescence and minimal functional impairment provided skeletal traction is properly employed.

3. A technique of closed reduction by skeletal traction, and details of post reduction treatment are given and a simplified traction frame is described.

COINCIDENT SURGICAL EXPOSURE AND RADIUM THERAPY IN THE TREATMENT OF EXTENSIVE CERVICAL CANCER¹

ARTHUR H. CURTIS, M.D. F.A.C.S., CHICAGO

THE number of cures of cervical cancer varies roughly from 25 to 30 per cent in the major clinics of all countries, irrespective of whether the growth is removed or is treated by radium. Generally speaking the results are very satisfactory in cancers not progressed beyond Stage I in which cases the growth is still limited to the uterus.

In Stage II cancer of the cervix, in which the growth has progressed beyond the uterus but is still relatively limited in extent, the prognosis is dubious. In Stage III cases, with induration of the parametrium and more or less fixation of the uterus, the outlook is well-nigh hopeless. In brief radical operation and radium treatment are relatively unsatisfactory both in Stage II and in Stage III cases, and it is apparent that other procedures are required for successful management of patients with these more extensive lesions. Radical operations have evidently reached their limit of efficiency and we therefore turn now to improved radiation and allied measures for further help.

In the pioneer days of radium treatment, attempts to obtain cures with massive doses resulted in a distressingly high incidence of destructive lesions of the adjacent viscera, often terminating in fistula formation or death. We learned relatively early that the pelvic viscera are highly susceptible to injury from radium burns and, particularly, that many cancers can not be cured because proximity of the bladder inhibits efficient radiation. With this in mind, I have for several years made a practice of separation and upward displacement of the bladder to permit more extensive use of radium in this region without introducing the danger of vesical fistula. The additional area thus made available for radiation has permitted intensive treatment of several cases of cervical cancer which could not otherwise have been satisfactorily radiated.

The value of dissection and retraction not only of the bladder but also of the other vulnerable tissues has become more and more apparent and has eventuated in a combined method of surgical exposure and coincident radium application. The suggestions advanced in this paper pertain particularly to treatment of the Stage II group of cases and to the less advanced cases of the Stage III group in which there is some hope of cure.

PROCEDURE

The necrotic cervical growth is treated with surgical diathermy or prophylactic radiation at least 3 weeks prior to operation. Preliminary deep X-ray therapy may serve equally well in healing the sloughing cancerous surface.

Under anesthesia, a preliminary pelvic examination is made to determine the extent of the growth and the amount of intervention required. Exposure of the cancer bearing uterus and adjacent cellular tissues is now undertaken. With blunt dissection, the bladder is mobilized upward, the cervix encircled with an incision as in making a radical vaginal hysterectomy and the vaginal mucosa painstakingly dissected laterally and posteriorly along natural lines of cleavage. The body of the uterus and the regions of the broad ligaments and cardinal ligaments are now well visualized. With the organ half delivered broadside vaginally the bladder safely anchored in its elevated position with a catgut suture holding it high on the uterus, and the paracervical tissues exposed, a massive radium treatment is possible. Radium needles or radon seeds are now inserted where needed, near to or into the cervix or far from it, as indicated with assurance of safety of the adjacent vulnerable organs (Fig. 4). Although the ureters are subject to possible injury they are considerably retracted incident to the dissection and displacement of the bladder and are relatively immune. Preliminary ureteral catheterization may merit consideration in selected cases, but we have not resorted to it. Injury of a uterine artery is a possibility. I have not yet seen that complication despite many years custom of introducing radium needles into the cervical parametrium. Palpation of the artery preliminary to burying a radium needle in its vicinity appears unnecessary.

After burying the radium needles (or radon) as described, a chain tandem of radium capsules is inserted into the uterine canal in the usual manner. A vaginal pack completes the procedure.

Until further experience warrants, the total radiation should not exceed 3,500 millicuries. Even that amount may be excessive.

REPORT OF CASES

CASE. Patient was admitted to Passavant Memorial Hospital January 9, 1933. She was a married woman of 58

From Passavant Memorial Hospital and the Department of Obstetrics and Gynecology, Northwestern University Medical School.



Fig. 1

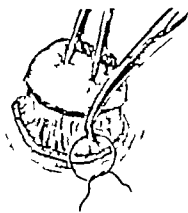


Fig. 2

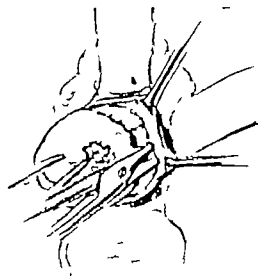


Fig. 3

Fig. 1. The bladder is mobilized and displaced upward.
Fig. 2. The cervix has been encircled with an incision stage of dissection of the vaginal mucosa.

Fig. 3. The vaginal mucosa is painstakingly dissected anterolaterally and posteriorly along natural lines of cleavage.

with two healthy children. Menopause occurred at 50 years of age, slight spotting of blood 10 years later in September 1932. Rather free bleeding on one or two occasions thereafter. No pain.

Examination. Patient's general condition was good, heart and lungs were normal, blood pressure 130/85, red blood count, 4,720,000, hemoglobin 75 per cent, Wassermann, negative. Vaginal examination revealed some urethrocele with incontinence, a relaxed perineum with slight rectocele and a long, narrow funnel-shaped vagina. The cervix, high up in the vaginal vault, nearly 4 inches from the vulva, presented a friable new-growth involving both lips. The cancerous tissue bled freely on manipulation. The wide extent of the growth in the cervix suggested some invasion of the parametrium. The uterus had limited mobility but there was no definitely demonstrable invasion of the broad ligaments.

Operation. On January 10, under nitrous oxide anesthesia, delivery of the cervix to the vulva was accomplished despite the markedly elevated position and limited mobility of the uterus. Extension of the growth was in close proximity to the bladder but the latter could be separated and was mobilized and advanced $1\frac{1}{4}$ inches higher on the uterus. A moderate treatment with surgical diathermy was administered to destroy the necrotic local growth.

Microscopic study revealed a richly cellular cancer containing many epithelial pearls and cells of varied size provided with abundant mitotic figures.

On February 16 the patient was re-examined, this time under ethylene anesthesia. There was found gross evidence of remaining malignancy of the anterior lip extending rather deeply into the cervical canal and laterally somewhat into the left broad ligament. The sloughing surface of the tumor was well healed.

Surgical procedure and radiation. The bladder which had returned to its normal position since the diathermy treatment, was readily mobilized and displaced upward. A circular incision around the cervix and blunt dissection of the vagina along natural lines of cleavage exposed freely the pillars of the bladder anteriorly, the broad ligaments and cellular tissues anterolaterally and the pillars of the rectum posteriorly. The bladder was now sutured to the body of the uterus in its reflected position in order to keep it out of the way during radiation. Seven radium needles were inserted about the cervix, chiefly laterally into the

bases of the broad ligaments. Seventy-five milligrams of radium in capsules, in tandem were placed in the uterine canal. All told a dosage of 3,000 milligram hours was given.

Postoperative course. The patient made an uneventful convalescence and left the hospital in a week. A notation on re-examination April 20 1932, reads as follows: The cervix appears to be entirely healed and is freely movable. There is no evidence of remaining displacement of the bladder or of the reflected vaginal walls, no pelvic induration, nodulation or tenderness. The patient feels fine, has no vaginal discharge, no urinary or bowel symptoms, is gaining weight, has a splendid appetite and seems to be well on the way to a clinical cure.

CASE 2. Patient was admitted to Passavant Memorial Hospital December 15 1932. She was a married woman of 46, formerly a graduate nurse. One pregnancy at the age of 18, terminated by spontaneous abortion in the fifth month. Menstruation had always been regular of the 28 day type, duration 5 days, until the menopause one year ago at the age of 45 years. Malaise and slight pelvic distress led the patient to insert a finger into the vagina 4 months prior to entrance into the hospital. She felt a mass but did nothing further until 3 weeks prior to entrance at which time she palpated a nodulation like a cauliflower. A dirty, blood-tinged discharge now appeared and persisted, with increasing bloody flow as time progressed.

Physical examination revealed the patient to be in fairly good general condition, heart and lungs, negative, blood pressure, 130/80, red blood count 4,160,000, leucocytes, 11,300, hemoglobin, 70 per cent, Wassermann, negative. The pelvic findings are included in the detail of the operations recorded below.

Surgical diathermy treatment. On December 17 under nitrous oxide anesthesia, the cervix was found to be enlarged to double normal size by a cauliflower-like necrotic tumor which involved the entire vaginal portion of the cervix and slightly invaded the vaginal wall in all directions. It was recorded that submucosal extension was apparently still more widespread than the surface growth and infiltration anteriorly had apparently progressed to the floor of the bladder. If not into it. "The generous sized uterus is freely movable although there must be some broad ligament invasion."

With painstaking delivery, the cervix was brought beyond the level of the vulva. Tissue was removed for biopsy

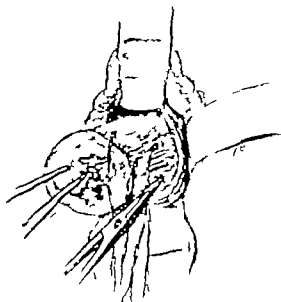


Fig. 4.



Fig. 5.

Fig. 4. The body of the uterus and the regions of the broad ligaments and cardinal ligaments are now well visualized. With the uterus partially delivered, vaginally the bladder safely anchored in its elevated position with a cat gut suture, and the paracervical tissues exposed, radium needles or radon seeds are now inserted where needed, as indicated, with assurance of safety of the adjacent vulnerable organs.

Fig. 5. Radium needles and chain tandem radium capsules in position. The placement of the needles is accurately portrayed in Figure 4.

Extensive surgical diathermy was given, moist gauze packing being employed to protect the adjacent tissues.

Histological study of the growth revealed an anaplastic epithelial cell carcinoma of the cervix.

Surgical procedure and radiation. January 17, 1933, ethyl-ene anesthesia. The diathermy treatment of a month previous, together with changes wrought by the cancerous growth, had resulted in complete destruction of the anterior cervix and major portion of the posterior part. Slight dissection revealed the bladder lying on the uterine canal with almost no intervening tissue. The uterus was mobile. Extension of the growth anteriorly apparently had not involved the bladder, but it was much distorted and its separation and upward displacement without injury was accomplished only with difficult, painstaking dissections. Lateral and posterior dissection of the vagina was followed by further tedious complete separation of the bladder from the uterus, including opening of the anterior cul-de-sac. An excellent delivery of an apparently hopelessly entangled and distorted uterus was obtained. The remaining shrunken organ was only 3 inches in length. Some fibrous and residual infiltration (apparently cancerous) persisted in the para-uterine cellular tissues, but evidently not beyond access of radiation now that the dissection had delivered the uterus and had displaced the vulnerable bladder and ureters. A palisade of 8 radium needles was inserted into the tissues around the cervix and into it and one 50 milligram tube of radium was placed in the uterine canal. A total of 3,000 milligrammes was administered.

Rectovaginal examination, two and two-thirds months subsequently April 5, 1933, revealed healing far progressed. The region of the uterus and its vicinity which had been raw and necrotic during the interval following the operation, was now almost healed. The retracted tissues (still somewhat retracted a month earlier) now covered the stump nicely. The mobility of the uterus remained limited but the outlook appeared encouraging.

CASE 3. Patient was admitted to Passavant Memorial Hospital November 2, 1931. She was 42 years of age, had previously been married, and had been divorced for 10 years. One birth, with normal delivery occurred at the age of 21. Menstruation had always been regular 28 day type, duration 4 to 6 days, with normal, painless flow until present trouble. Routine examination by a physician 3 months ago revealed a raw, ulcerated area on the cervix. No improvement with local treatments. She flowed persistently following regular period 1 month prior to entrance and thereafter bled rather freely alternating with periods of spotting, until time of entrance.

Physical examination revealed a rather pale, fairly well nourished, somewhat nervous patient. Heart and lungs were negative; blood pressure, 116/66 red blood cells, 3,810,000 leucocytes, 8,550 hemoglobin, 75 per cent.

Examination and radium treatment. November 3, ethyl-ene anesthesia. Although superficially limited, the friable, bleeding lesion near the external os of the cervix was found to be an extensive endocervical cancer apparently originating within the cervical canal. The fundus was of generous size, retrodisplaced, mobile. Gentle removal of the endocervical cancerous debris left a cavity half the diameter of the cervix, beyond which the growth had apparently extended into the left parametrium. The prognosis appeared unfavorable. A palliative intra-uterine treatment with radium capsules was given.

Microscopic examination revealed a loose fibrous stroma containing islands of a squamous cell, group 3, mild to ripe growth.

On January 26, 1932 the patient was again given ethyl-ene anesthesia. The fundus of the uterus was found to be large and mobile. There was a palpable thickening anteriorly on the left. The cervix was cancerous, the lower uterine segment slightly obstructed. Dilatation yielded some retained serohemorrhagic fluid.

The bladder was separated from the cervix, displaced upward and anchored with one catgut suture. Light radium needles were buried in a pallade encircling the cervix and 75 milligrams of radium in 2 capsules in tandem were placed in the canal. A total radiation of 1,750 millicuries was given.

Surgical exposure and radium treatment. The patient was kept under observation, with bimanual rectovaginal examination at monthly intervals. Her isolated social status and the need of a complete understanding of her condition because of her dependent child led to a frank discussion of the prognosis. The clinical course continued excellent but there remained an infiltration in the left parametrium. After prolonged temporizing it was finally decided that radical intervention was preferable to expectancy this despite the fact that increasing infiltration could not be determined with certainty.

Operation February 14, 1933, ethylene anesthesia. As a result of the previous radium treatments, the uterus presented the appearance of a clinical cure. The external os was sealed, the canal $2\frac{1}{2}$ inches in depth, the size of the uterus normal. The bladder was flush with the cervix and there was considerable edema in the region of the pillars. There was moderate uterine mobility with some palpable "fullness" in the left parametrium.

The bladder was separated and displaced upward 3 inches. A circular incision around the cervix was followed by separation of the vaginal mucosa posteriorly and laterally thus exposing the broad ligaments thoroughly and extending upward posteriorly to the pillars of the rectum. With the uterus thus mobilized and the bladder held up by a fixation suture, 7 radium needles were thrust into the left broad ligament, and high into the cervix anteriorly and less high posteriorly and laterally all under digital control of the left hand, with the forefinger in the vagina and the mid-finger in the rectum to protect against bowel injury. Seventy five milligrams of radium in 2 capsules were placed in the uterine canal. A total radiation of 3,075 millicuries was given.

Postoperative course. The patient left the hospital after an uncomfortable week. There was no palpable exudate. A month later the uterus was somewhat descended, heavy, "lumpy" raw discharging and apparently still uncovered by mucosa (speculum examination was avoided because of excruciating tenderness).

Very recently 3 months after operation and radiation, the patient returned to the hospital because of pelvic distress. Speculum examination revealed considerable necrosis of the cervical portion of the uterus, and some of the adjacent parametrium. There was a rather free serous discharge containing fragments of debris. The bladder and ureters, apparently in excellent condition, had returned to normal position. The lateral vaginal walls were no longer retracted. Rectovaginal examination indicated a normal bowel and revealed no pelvic exudate, but some brawny fixation, and the patient experienced discomfort in the region of the rectosigmoid. Despite the rather extensive tissue destruction, which was more than anticipated or desired, it appeared that the process was subsiding without serious complication.

In view of the fact that these three patients have been cared for within the last several months it is evident that a prognosis as to the ultimate outcome is unwarranted. Yet the fact that intensive radiation can be accomplished without injury to important structures must lead

to a more encouraging outlook in cases of this character.

Complete surgical recovery has occurred in one of these cases, with accompanying gross disappearance of the growth and free mobility of a now apparently healthy uterus. A second patient has made an almost complete surgical recovery, except for some irregularity in contour of the uterus incident to partial destruction of the cervix and lower uterine segment. The third patient has, at the present time, some necrosis of the cervix and adjacent cellular tissues with considerable associated pelvic cellulitis and profuse discharge which contains some fragments of tissue. The bladder and ureters are in excellent condition despite the nearby destructive process this bladder would undoubtedly have been injured by the radiation had it not been spared by preliminary dissection and retraction at the time of treatment.

The raw surfaces created by the dissection in these cases apparently need cause no concern. The dissected tissues gradually fall back into their normal positions after removal of the radium. The use of sutures is unnecessary. Even the bladder reflection despite the anchoring suture of catgut which holds it in upward displacement during radiation quickly resumes its natural position.

Further experience may require modification in the detail of the procedure. We are most concerned with the value of the underlying principles involved.

It has been thought by some that implantation of radon seeds into the cancer bearing pelvic tissues at the time of abdominal operation may prove to be a decided asset in our fight against cancer. Gellhorn has made intra abdominal implantations of radon, under guidance of the other hand, within the vagina. He then closes the abdomen and makes the usual vaginal introduction of radium. Perhaps intra-abdominal placement of radon may be advantageously employed in conjunction with the procedure herewith suggested.

CONCLUSIONS

- 1 The feasibility of coincident surgical exposure and radium therapy in the treatment of extensive cervical cancer has been demonstrated in three cases.

- 2 It is my belief that acceptance of the principle of combined vaginal approach and appropriate radium therapy will result in an improved prognosis in many relatively extensive cases of carcinoma of the cervix which have heretofore had a dubious outlook.

THE TREATMENT OF DUODENAL FISTULA

INCLUDING A REPORT OF TWO NEW CASES AND A REPORT OF A NEW BUFFER SOLUTION

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ANY surgical complication having a reported mortality of 50 per cent must of necessity be studied carefully. Furthermore when death may supervene 1 or 2 days after the complication arises, it certainly behooves the surgeon to be well acquainted with its diagnosis and the various kinds of treatment, so that he may start the most efficient treatment immediately. A patient with duodenal fistula becomes debilitated with extreme rapidity by inanition, dehydration, and the loss of chlorides. It becomes one of the most ravaging and one of the most disconcerting conditions with which the gastro-intestinal surgeon has to deal. It inspires dread both because of its high mortality and its extremely rapid course.

An attempt is made in this paper to review the literature on the subject since 1865—94 cases—and to add 2 of our own, making a total of 96 cases. This is the largest series of cases reported in any paper so far. There are but few reports of the condition before 1900. When recognized it was dealt with haphazardly and the results were consequently poor. We found no case with recovery reported in medical literature before 1900. During this period, the treatment was medical and altogether conservative. Possibly for this very reason, the treatment became surgical for the next 25 years. The mortality rate which had been 100 per cent, dropped to between 43 and 50 per cent. Since 1927 the treatment has again become medical but based on radically different principles. The mortality rate has dropped markedly. The late reports on the present treatment are so good that it may become the treatment of choice, since at least one good sized series shows 100 per cent recovery.

Lilienthal reported the first two cases of duodenal fistula treated by surgical means, in 1901. Two years later von Cackovic collected 6 additional cases from the literature, all of whom died after having been treated conservatively. In 1917 Melchoir reported on 14 cases, while Colp reviewed 53 cases in the literature and added 8 of his own in 1923. In the same year Cameron reported on 29 cases. In 1929 Potter (50) reported on a series of 9 cases treated medically with no deaths. These various reports seem to prove that duodenal fistula is not so rare a condition as one

might at first conclude. The success of recent medical treatment definitely disproves the view of Pannet who stated that "duodenal fistula never healed without surgical aid and if left was invariably fatal."

Duodenal fistula may result from various causes and the point of exit may be almost anywhere on the abdomen or on the back. Trauma of the duodenal wall may result in necrosis and abscess, which in turn may gravitate and rupture far from its origin. In Forster's case of retroperitoneal perforation, the pus ascended along the great vessels and localized in the neck. Wagner and Fenwick cite cases in which the burrowing fluid localized in the inguinal region and autopsy proved the connection with the retroperitoneal second portion of the duodenum. Other such cases are cited by Koerte, Esau, and Hinton (35). Quite often the fistula is the result of operative interference on or near the duodenum. The wall of the duodenum may become traumatized or its blood supply compromised. Mayo (39) cited 3 cases in which the duodenal wall was injured in performing right nephrectomies. Other cases are cited by von Cackovic, Payr and Thevenard. The duodenum may also be injured easily in dissecting away adhesions during gall-bladder operations. Such cases were recorded by Fink, Meyer and Merk. Fistula may also follow accidental opening of the duodenum or transduodenectomies for the extraction of stone in the common bile duct. Various types of resection of the stomach may be followed by fistula as is shown by the cases cited by Melchoir, Makkas, Kelling, and Cameron.

Perforated duodenal ulcer, when this condition has been treated with simple suture is another very common cause of duodenal fistula. The greatest care must be taken that the suture lines are perfect. A minute leak will enlarge shortly and result in fistula. The natural activity of the stomach and duodenum encourages such a result. As the stomach empties its contents into the duodenum, the duodenal pressure is greatly increased and sutures cut through the brittle wall. Many such cases are cited in Table I.

Gauze packing is one of the most important contributing factors in the formation of duodenal fistula. Particular stress was laid on this point by

Cameron. In this location, there is a great deal of edema of sutured tissue. Gauze packs increase this edema possibly to the point of interfering with the circulation. There may be also a slight adherence between the sutures and the gauze. Then, upon the removal of the gauze, naturally slight pulling on the sutures results and this would in turn result in some enlargement of one or more suture openings. Even such a small opening may become enlarged rapidly by the action of the trypsin of the pancreatic juice and become the starting point of a fistula. Furtwangler stated that most severe forms of fistula resulted from leaking sutures.

Infection of the suture lines is undoubtedly another contributing cause. This is especially true in cases of ruptured duodenal ulcer. Infection prepares the way for leaking sutures and for perhaps rupture of the entire suture line by increasing the edema and by rendering the bowel wall more brittle. Due to their injury the tissues are below par. Their blood supply is compromised. The natural local resistance of the tissue is greatly lessened due to this lessened nutrition.

The strong digestive action of the pancreatic trypsin is the most important primary cause of duodenal fistula. It attacks the proteins of the living tissues and is highly destructive. It is this ferment that seeps through small suture leaks and rapidly enlarges them. Furthermore there is no healing while the trypsin remains active in the wound. The whole wound usually breaks open and rapidly enlarges. Potter stated, in his discussion of the digestive activity of the fistular fluid, that the bile played a minor rôle although it did attack the fat of the abdominal wall. The trypsin was by far the most damaging, he stated.

The diagnosis offers no great difficulty in the great majority of cases, especially if the complication of duodenal fistula is kept in mind. According to Table I, the time of onset may vary from 2 days to several months. On the average the time of onset is from 5 to 14 days. Often-times the onrush of the fistular fluid follows the gauze pack as it is removed. When the tryptic fluid has once broken through the onset of the fistula is very rapid and the amount of fluid coming through may be enormous. The operative wound usually breaks open along its entire length. The wound becomes extremely tender and the skin around the wound edges becomes inflamed and bleeding. Most patients complain of a feeling of severe burning in the entire wound and the adjacent skin surface. The fat in the adipose layer becomes digested and the wound takes on an excavated appearance. The walls of

the blood vessels along the margin of the wound may become digested and bleeding from the wound may be of alarming proportions. The chemical reaction of the fluid discharge is usually strongly alkaline in the worst type of fistula. Should the fluid discharge be acid in reaction, the fistula is probably suprapapillary in origin.

There seems to be considerable variation in the destructiveness of various fistulas and in the toxemia accompanying them. This of course depends on the size of the fistular opening and the tortuosity of the tract. The point in the duodenum where the fistula originates is another very important factor. It is either suprapapillary or infrapapillary according to whether it is above or below the papilla of Vater. This distinction is of great prognostic value since suprapapillary fistulas certainly are not nearly so destructive as those originating below the papilla of Vater. However fistulas that follow the Billroth II type of operations usually contain bile and these fistulas are excellent examples of the suprapapillary type. It is also well known that pancreatic ferments may be carried retrograde by antiperistaltic waves of the duodenum. Payr reported an infrapapillary fistula with absence of bile and pancreatic ferment in the secretion.

The type of duodenal origin of the fistula probably has a great deal to do with the amount of the discharge. It is easy to conceive that if the origin is well down along the lateral wall of the duodenum there would be more resistance to the escape of fluid than would be the case if the opening were situated on the anterior wall. Either a right or left sided opening would have a tendency to a valve-like effect. But no matter where the opening the fact remains that a duodenal fistula greatly excites the stomach to activity. The intestinal law of Bayliss-Stirling states that stimuli applied to the duodenum produce a muscular excitation in oral direction and a muscular relaxation in aboral direction. Barsony and Hortobagyi also showed that experimental duodenal fistula greatly increased the muscular activity of the stomach. This was shown graphically in their experiments.

The prognosis of duodenal fistula is always grave. The duodenum has its own succus entericus and also receives the bile, the gastric contents, and the powerful pancreatic secretions. A fistula therefore, causes loss of intestinal juices and all foods and fluids ingested. It is like turning off a mill race suddenly. Inanition dehydration and exhaustion comes on with extreme rapidity. The introduction of fluids rectally, intravenously, and by hypodermoclysis control

TABLE I.—GENERAL DATA, VARIOUS TREATMENTS, AND FINAL RESULTS

Surgeon Date	Diagnosis	Operation	Type of Drainage	Time of symptoms of fecula	Type of treatment	Length of life after treatment was instituted	Final result
Cramer 1895	Perforated duodenal ulcer	None	?	?	Conservative	1 month	Died
Hinton 1896	Rupture of duodenum	None	?	Several mos. later	Conservative	30 years	Died
Rand 1897	Intestinal tuberculosis	None	?	days	Conservative	30 days	Died
Lewis 1898	Perforated duodenal ulcer	None	?	90 days	Conservative	3 months	Died
Farrick 1900	Rupture of duodenum	None	?	42 days	Conservative	6 months	Died
Kruke 1901	Cholelithiasis	Cholecystectomy	Tampone	days	Attempted suture	1 month	Died
Mack 1901	Cholecystitis	Cholecystectomy	Tampone	1 day	Conservative	70 days	Cured
Cocke 1901	Sarcoma	Hepatectomy	Tampone	70 days	Jehnnstony 17 days	9 days	Died
Korn 1904	Rupture of duodenum	Suture	Tampone	60 days	Suture. Jehnnstony 5 weeks	days	Died
Mc 1904	Perforated duodenal ulcer	Suture, gastro- enterostomy	Tampone	?	Conservative	?	Died
	1 Perforated duodenal ulcer	Suture	Tampone	?	Conservative	Healed	Cured
Leah 1905	Cholelithiasis	Cholecystectomy	Tampone	8 days	Gastro-enterostomy and suture at 22 days. Perforation and re-suture	?	Cured
Leah 2.	(1) Cholecystitis	Cholecystectomy	Tampone	8 days	Conservative	days	Cured
	Cholelithiasis	Cholecystectomy	Tampone	1 day	Suture at days	Recessed 11 days healed 16 days	Cured
	(2) Cholelithiasis	Cholecystectomy	Tampone	8 days	Suture 9 days	Suture 12 days gastro-ent. 17 days	Died
	(3) Cholelithiasis	Cholecystectomy	Tampone	30 days	Conservative	43 days	Cured
	(4) Cholelithiasis	Cholecystectomy	Tampone	days	Conservative	18 days	Cured
Wagner 1906	Perforated duodenal ulcer	None	None	8 months	Conservative	5 months	Died
Berg 1907	(1) Carcinoma pancreas	Cholecyst duodenostomy	?	1 day	Ant. gastro-ent. with pyloric occlusion	Discharge stopped 21 mos. 67 days cured	Died of ca.
	(2) Perforated duodenal ulcer	Suture of perforation	?	1 day	Post. gastro-ent. duodenal occlusion	Recessed 3 days pylorus occluded	Died
Melhan 1907	(1) Carcinoma of stomach	Bilroth I	?	30 day	Suture 3 days	day	Died
	(2) Pyloric tumor	Bilroth I	?	days	Conservative	month	Died
	(3) Stomach tumor	Bilroth II	Tampone	6 days	Conservative	days	Died
Kasson 1908	Perforated duodenal ulcer	Incision of pyloric abscess	None	Several weeks	Post. gastro-ent. pyloric occlusion 3 months	At once	Cured
Casson 1908	?	?	?	?	Post. gastro-ent. pyloric occlusion	Healed at once	Cured
Highy 1911	(1) Rural tuberculosis	Nephrectomy	?	Few weeks	Conservative	Healed	Cured
	(2) Perforated duodenal ulcer	Drainage of abscess	Tampone	1 day	Conservative	9 days	Cured

TABLE I—GENERAL DATA VARIOUS TREATMENTS AND FINAL RESULTS—Continued

Surgeon Date	Diagnosis	Operation	Type of drainage	Time of appearance of fistula	Type of treatment	Length of life after treatment was instituted	Final result
East 1912	Nephrectic abscess	Nephrectomy	Tampon	3 days	J jejunostomy	6 days	Died
Telford 1912	Perforated duodenal ulcer	Esection of abscess	Tampon	3 days	Suture and gastro-enterost.	6 days	Died
Whitwarter 1912	Rupture of duodenum	Suture	Tampon	2 days	Enterostomy	2 days	Died
Struthers 1913	Ruptured duodenal ulcer with fistula (3 cases)				Conservative (sickers not (I) ref)		All three died
Souther 1913	Perforated duodenal ulcer	Suture and post gastro- enterostomy	?	?	Post. gastro-ent. pyloric occl.	Recovered	Cured
Therrenard 1913	?	Nephrectomy	?	?	Gastro-enterost. Beck. pan.	9 days	Cured
Turner 1913	(1) Perforated duo. ulcer	Duodenorrhaphy	Tampon	3 days	Conservative	8 days	Died
	(2) Cholelithiasis	Cholecystectomy	Tampon	3 days	Conservative	3 days	Died
Mayo 1914	(1) ?	Nephrectomy	?	3 days	Conservative	14 days	Died
	(2) Carcinoma of kidney	Nephrectomy	?	3 days	Conservative	9 days	Died
	(3) ?	Nephrectomy	?	?	Conservative	14 days	Died
	(4) Kidney stone	Nephrectomy	Tampon	2 days	Suture at once	Healed	Cured
Mitchell 1914	Carcinoma of stomach	Bilroth I	Tampon	12 days	Conservative	Healed in 1 year	Cured
Pannet 1914	Perforated duodenal ulcer	Duodenorrhaphy	Tampon	3 days	Jejunostomy	Healed 15 days	Cured
Chesver 1915	Ruptured duodenal ulcer	Duodenorrhaphy	Tampon	3 days	Irrigation	Healed 11 days	Cured
Devie 9 8	Duodenal-ureteral fistula	Nephrectomy	?	4 days	Conservative	Healed 8 days	Cured
Gardner 1918	Gall stones	Cholecystectomy	?	9 days	Conservative	Healed 1 month	Cured
Palmer 918	(1) Carcinoma of stomach	Bilroth II	Tampon	8 days	Conservative	Healed 24 days	Cured
	(2) Gall stones	Cholecystec. duodenorrhaphy	Tampon	6 days	Conservative	Healed 28 days	Cured
Elkhorst 1918	(1) Biliary fistula	Clostra	?	7 days	Duodenal tube per os	Healed 17 days	Cured
	(2) Cholecystitis	Cholecystectomy	Tampon	11 days	Duodenal tube jejunal feeding	Healed 5 months	Cured
Clark 9 9	(1) Cholecystitis	Cholecystectomy	Tampon	17 days	Conservative	Healed 20 days	Cured
	(2) Cholecystitis	Cholecystectomy	?	3 days	Jejunostomy	Lived 3 days	Died
Hendon 1919	Cholangitis	Exploratory	Tampon	At once	Conservative	Healed 5 weeks	Cured
McGohre 919	Cholecystitis	Cholecystectomy	?	9 days	Jejunostomy	Healed 3 weeks	Cured
Meyer 1920	Cholecystitis	Cholecystectomy	Tampon	?	Conservative	Healed 7 months	Cured
Erdmann 1921	Duodenal rupture	Duodenorrhaphy	Tampon	6 days	Jejunostomy	Healed 18 days	Cured
Stadler 1921	Rupture of gall bladder	Drained abscess	Tampon	3 days	Oliver of tampon	Healed 1 month	Cured

TABLE I.—GENERAL DATA, VARIOUS TREATMENTS, AND FINAL RESULTS—Continued

Surgeon Date	Diagnosis	Operation	Type of drainage	Time of appearance of abscess	Type of treatment	Length of life after treatment was instituted	Final result
Forrester 1918	River on abdomen	Abdominal aperturostomy	No	5 weeks	Past gastro- enterostomy	Lived 3 days	Dead
Colp 1917	() Cholecystitis	Cholecystectomy cholecystostomy	Drainage	5 days	Gastro-enterostomy, pyloric occlusion	Lived 6 days	Dead
	() Cholecystitis	Cholecystectomy cholecystostomy	Drainage	7 days	Gastro-enterostomy, pyloric occlusion	Lived 1 day	Dead
	(1) Cholecystitis	Cholecystectomy	Drainage	20 days	Conservative	Healed 45 days	Cured
	(4) Cholecystitis	Left hepaticoduodenostomy	Drainage	16 days	Gastro-enterostomy with pyloric occlusion	Lived 1 hour	Dead
	(5) Cholecystitis	Cholecystectomy cholecystostomy	Drainage	7 days	Gastro-enterostomy, pyloric occlusion, cholecystostomy	Lived 20 days	Dead
	(6) Cholecystitis	Cholecystectomy	?	?	Conservative	Healed 4 months	Cured
	() Cholecystitis	Cholecystectomy cholecystostomy	Drainage	5 days	Conservative	Healed 20 days	Cured
	5. Volvulus of jejunum	Duodenostomy	Drainage	5 days	Conservative	Lived 20 days	Dead
Cameron A. L. 1917	Small intestine	Anterior Pity	Soft rubber drains	7 days	Used continuous suction 10 days	Healed 11 days	Cured
Greenberg, A. 1917	Pyloric aneurysm	Bulbostomy II	?	10 days	By-passing 10 days	Healed	Cured
R. Smith, A. 1917	Cholecystitis	Cholecystectomy duodenostomy	Packing	At once	6 weeks	Healed	Cured
Parson, A. 1917	Peritonitis	Nephrectomy	?	5 days	Conservative	Lived 1 month	Dead
Krein 1917	() Perforated duodenal ulcer	Sutured and covered with omentum	Rubber tube	7 days	Past gastro-enterostomy duodenal occlusion	20 days	Cured
	() Right pyelonephritis	Nephrectomy	?	10 days	Conservative	60 days	Cured
	(1) Ruptured appendix	Appendectomy	Two tubes and packing	5 days	Conservative	10 days	Cured
	(4) Duodenal diverticulitis	Removal of diverticulum duodenostomy	Gastric drainage	5 days	Conservative	14 days	Cured
	(5) Subphrenic abscess	Drainage	Drainage	At once	Sutured	At once	Cured
	(6) Cancer of stomach	Partial gastrectomy	?	22 days	Conservative	9 days	Cured
	(7) Cancer of stomach	Partial gastrectomy	?	5 days	Conservative	5 weeks	Cured
Walsh, C. W. 1917	Pyptic ulcer	Past gastro- enterostomy	Drainage	8 days	Conservative	16 days	Cured
Lick, Morris 1917	Perforated duodenal ulcer	Secure and past gastro-enterostomy	Cigarette drains	5 days	Drainage by suction	8 days	Dead
Albright 1917	Ovarian cyst, appendicitis	Ovariectomy appendectomy	Bowel opened occasionally	At once	Inserted rubber tube	4 weeks	Cured
Wheeler 1916	Perforated duodenal ulcer	Secure	Drainage	9 days	Conservative	25 days	Cured
Gilley, Hobart 1916	Gall stones	Cholecystectomy	?	4 days	Sutured jejunum omental mass	nil	Cured
Johnson 1917	() Cholecystoduodenostomy	?	?	?	Injected per cent citric acid	10 days	Cured
	() Cholecystitis	Cholecystectomy	?	30 days	Injected per cent citric acid	20 days	Cured
Patton 1917	Ruptured gastric ulcer	Suture of ulcer	Soft drains	9 days	Unsuccessful closure Section 100% but jejunum stomach	30 days	Cured

TABLE I—GENERAL DATA VARIOUS TREATMENTS AND FINAL RESULTS—Continued

Surgeon Date	Diagnosis	Operation	Type of drainage	Time of appearance of fistula	Type of treatment	Length of life after treatment was instituted	Final result
Potter C. 1919	(1) Perforated duodenal ulcer	Appendectomy suture	Large drains	At once	HCL 1/10 normal, buffer solution of olive oil and beef juice	25 days	Cured
	(2) Perforated duodenal ulcer	Ulnar inverted	Large drains	8 days	HCL 1/10 normal, buffer solution of olive oil and beef juice	11 days	Cured
	(3) Pus tubes and abscess	Drainage	Large drains	4 days	HCL 1/10 normal, buffer solution of olive oil and beef juice	Healed	Cured
	(4) Appendicitis and obstruction	Jejunostomy	Large drains	At once	HCL 1/10 normal, buffer solution of olive oil and beef juice	Healed	Cured
	(5) Appendiceal abscess	Jejunostomy	Large drains	At once	HCL 1/10 normal, buffer solution of olive oil and beef juice	30 days	Cured
	(6) Cholecystitis	Cholecystectomy jejunostomy	?	At once	HCL 1/10 normal, buffer solution of olive oil and beef juice	Healed	Cured
	(7) Gastric and duodenal ulcer	Partial gastrectomy	?	7 days	Used acetic acid	35 days	Cured
	(8) Intestinal obstruction	Enterostomy	?	At once	Used acetic acid 3 weeks then HCL	8 weeks	Cured
Worthen 1920	Perforated duodenal ulcer	Attempted closure	?	?	Conservative for 7 wks. then suture	1 day	Cured
Kittelson 1933	(1) Acute appendicitis	Enterostomy	Drainage	At once	1/10 normal HCL, lactose milk for buffer solution	1 day	Cured
	(2) Cholecystitis	Cholecystectomy	Drainage	5 days	1/10 normal HCL, lactose milk for buffer solution	9 days	Cured

the situation only partially. The toxic intestinal contents are undoubtedly absorbed along the fistulous tract. Studies of intestinal obstruction have shown that the pancreatic juice is very toxic—much more so than the contents of the cæcum.

This toxæmia has been very well described by Haden and Orr, Potter, and Walters. They stated that it was the result of rapid dehydration, due to the large volume of fluids lost and to the rapid depletion of chlorides. These factors caused an increasing alkalemia characterized by decreasing concentration of blood chlorides and progressive increase of blood urea. Walters concluded that the main cause of the toxæmia was the loss of the protective action of the chlorides of the digestive juices, which were discharged through the fistula. He thought that this loss turned the tide of neutrality of the blood toward alkalinity. He stated further that any toxic state is accompanied by increasing blood urea, due in some cases to the production of a nephritis which prevents the elimination of urea. At times it may be due to an

abnormal amount of urea formed from the breaking down of body tissues. Potter stated that the toxæmia associated with duodenal and fecal fistula is practically the same as that associated with intestinal obstruction.

As shown in Tables II and III the treatment of duodenal fistula has a mortality of 35.8 per cent. However separating the two major types of treatment, surgery has a mortality of 50 per cent, while the conservative treatment has a mortality of only 27.7 per cent. W J Mayo closed one case of posterior fistula successfully while Cameron cited five failures in six attempts. The toxæmia present in these patients is so severe that if operative procedures are resorted to before they at least have partially recovered, a fatal outcome is almost a certainty. Of the surgical procedures, simple closure, jejunostomy and enterostomy, carries the least mortality. Posterior gastro-enterostomy together with simple closure or combined with pyloric occlusion shows 7 deaths to 6 successful outcomes. Posterior

TABLE II.—RESULTS OF VARIOUS KINDS OF CONSERVATIVE TREATMENT

Treatment	Cases cured	Deaths
1. Ointments, applications, dressings	27	19
2. Olive oil tampon	1	0
3. Irrigations	1	0
4. Duodenal tube per os	2	0
5. Hydrochloric, acetic, or citric acid	11	0
6. Drainage by suction or syphon	3	0
7. Use of T shaped rubber tube	1	0
Totals	46	19
Per cent	72.3	27.7
Grand total of 65 cases treated conservatively		

TABLE III.—RESULTS OF VARIOUS TYPES OF SURGERY PERFORMED ON DUODENAL FISTULA

Kind of operation	Cures	Deaths
1. Simple suture	5	4
2. Jejunostomy	3	4
3. Enterostomy	0	1
4. Gastro-enterostomy and suture	1	3
5. Gastro-enterostomy and Beck's paste	1	0
6. Gastro-enterostomy and pyloric occlusion	5	4
Totals	15	15
Per cent	50	50
Grand total of 30 cases treated by surgery		

gastro-enterostomy with pyloric occlusion was first practiced by Berg and has proved successful in stopping the discharge at once. Jejunostomy is a great aid in stopping the discharge and is not nearly so dangerous. Direct closure of the fistula has been tried many times but the sutures usually fail to hold and the fistula recurs.

Einborn (11) employed the use of the duodenal tube in 2 cases successfully. In one of his cases the tryptic action was very marked. The tube was introduced *per os* and was kept in place for 2 days. It supplied food and water in abundance at small risk and lessened the discharge markedly. However the duodenal tube can not be used in cases of pyloric obstruction and in cases of resections of the stomach of the Billroth II type.

A constipating diet has been advocated. It is given with the idea of solidifying the intestinal contents and thereby lessening the flow of fluid through the fistula. Boiled milk has been used for the same reason. However the nausea and vomiting associated with the toxemia oftentimes renders any kind of feeding difficult. Rectal feeding is of some help but usually the time of healing is too long and the body weight can not be kept up. Oral administration of opium has been given to lessen the peristaltic action of the bowels.

Attempts have been made to dilute the trypsin. Cheever used a continuous stream of water to which had been added an alkali. He stated that the results on the fistula were good but that he had to discontinue its use because of irritation to the skin. Palmer also diluted the discharge with water to which he had added an alkali. There are other numerous references in the literature to attempts of healing the fistula by increasing the alkalinity of the discharges. Perhaps the minds of these workers were influenced by the fact that gastric ulcers heal under alkaline therapy.

Continuous suction was first used by Jones and Williams. Cameron used continuous suction on a case in 1923 with good results and Lahey used this method in 1924. It has certain very definite

advantages. The wound is kept fairly dry and this lessens the irritation in the wound and in the fistulous tract very much. The patients are much more comfortable locally. However, the loss of intestinal fluids is just as great as before. The toxemia, being dependent on the loss of chlorides and a beginning alkalosis, would probably not be influenced very much. The method is of value in cases in which the fluid loss is moderate and the toxemia of mild degree. The general condition of Cameron's case was good at all times and the fluid loss moderate.

It remained for Caryl Potter in 1927, to introduce a marked improvement in the conservative treatment of duodenal fistula. He first acidified the discharge by adding one-tenth normal hydrochloric acid in a continuous stream deep into the fistula. He then packed the wound with gauze which he kept soaked with a mixture of olive oil and beef extract. In other words, he first attempted to inactivate the trypsin by acidification and, then, supplied a buffer solution on which the bile could act without attacking the living tissues. There was also protein in the buffer solution to neutralize whatever trypsin might not have been acidified by the hydrochloric acid and thus rendered inactive. By these means he was able to stop the digestive action of the discharges at once and gave the fistula a chance to heal. He supplied fluids and dextrose abundantly as well as nutrient enemata. By these means the toxemia and the starvation were held in abeyance while the fistula healed. In 1929, he reported 9 cases which had been treated with this method with no deaths. This is the largest and the most successful series of cases treated by any one method.

Warnhaw and Hoffman, in 1930, treated a case successfully using Potter's method with a slight variation in buffer solution. They used a 10 per cent solution of Witte's peptone instead of Potter's mixture of beef juice and olive oil. They stated that they preferred the peptone solution

because of its greater ease of preparation. They also named three other solutions that might be used: egg albumen, protein milk powder and French glue.

In my 2 cases, the trypsin was acidified and thus rendered inactive by allowing one tenth normal hydrochloric acid to run deep into the fistula by means of a catheter. The wound was then kept packed with gauze which contained within it a second catheter supplying the gauze with the buffer solution, according to the arrangement of *Warshaw and Hoffman*. Each catheter ran back to a container, one for the hydrochloric acid and one for the buffer solution. The buffer solution used was whole lactone milk and this proved very satisfactory. It was prepared as follows. Whole milk was taken and re-pasteurized. Then this milk was cultured with stock culture of *Bacillus acidophilus* and kept warm for 6 hours, when it was quite thick. It was then placed in the container and used as a buffer. It was determined to try this after reading the work of *Charles E. North* on the beneficial action of lactic acid bacteria in the treatment of chronic fistula. The effect of the treatment was noticed immediately. The digestion of the tissues stopped at once and the pain ceased. The wound started to granulate. The fluid loss became less and less. The toxemia, which had been increasing rapidly, seemed to have improved almost over night. The two fistulas healed in 14 days and 3 weeks respectively. This treatment was supported by milk and egg enemas and by large amounts of fluid by the intravenous route as well as by hypodermoclysis.

SUMMARY AND CONCLUSIONS

An analysis of the 66 cases of external duodenal fistula reported in this paper shows that in 30 cases the fistulas followed operations on the gall bladder, in 22 cases operations for perforated duodenal ulcer, in 8 cases after nephrectomy, in 8 cases after resections of the stomach for malignancy, in 7 cases after operation, for acute appendicitis with obstruction, in 6 cases after rupture of the duodenum, and in 7 cases from other causes. Sixty five patients were treated conservatively with a mortality of 27.7 per cent and 30 patients were treated by surgery with a mortality of 50 per cent. The mortality for the whole group including all types of treatment, was 35.8 per cent.

In view of these statistics, it is seen that the prognosis of duodenal fistula is grave. The prognosis is most favorable when the fistula follows cholecystectomy when it is 26.7 per cent. Fistulas

following nephrectomies have had the highest mortality in this series, namely 80 per cent. Those following ruptured duodenal ulcer come next with a mortality of 50 per cent.

The statistics gathered seem to show that surgery in duodenal fistula has had its best results when used either very early or else very late. Conservative methods have had the best results. Potter's treatment, namely rendering the trypsin inactive by acidifying it by one-tenth normal hydrochloric acid and supplying buffer solutions containing fats and proteins has so far had perfect results. It seems that this treatment will become the treatment of choice.

Numerous buffer solutions have been used and have proved their value. Such solutions should contain fat and protein. A new buffer solution is offered to the profession namely whole milk thickened by the addition of *Bacillus acidophilus*. It was easily prepared and was used with complete success in my 2 cases.

REPORT OF CASES

CASE 1. Mrs. M. O., a white woman aged 45 years, had been well until she suddenly developed severe abdominal pain. Her family physician thought she was suffering from constipation and prescribed castor oil and enemas. She was seen by me 36 hours afterward and was then extremely sick. Her temperature was 104.5 degrees, pulse 120, respiration 36. The abdomen was distended rigid and very tender throughout. She was vomiting fecal material. A mass could be palpated in the region of the lower right rectus and the cul-de-sac was tender and boggy. A pre-operative diagnosis of acute appendicitis, probably ruptured was made.

At operation a ruptured gangrenous appendix was found. The pus cavity extended from the hepatic flexure to the pelvis. The small bowel was very much distended and it was evident that there was obstruction present. The appendix was removed without purse string suture and the cavity drained. An enterostomy was performed on the presenting loop of bowel, a No. 20F catheter being used. The abdomen was then closed with drainage.

The convalescence was rather stormy for the first 4 days, then quieted down, and the patient seemed to get along very well. Considerable pus drained from the wound and gas and fecal material drained from the enterostomy tube. The bowels moved and the enterostomy tube was removed. Then, on the thirteenth day after operation, the wound was wet and very tender. The patient complained of a burning sensation in the wound. The dressings were stained yellow and had an acrid odor. In 12 hours the whole wound had broken open and had almost doubled in size in 24 hours. The patient was very toxic and at the end of 24 hours was semi-stuporous. The amount of liquid coming from the fistula was so copious that the dressings had to be changed every 15 minutes. It was determined to use Potter's treatment and the wound was dressed accordingly. The beef juice and olive oil mixture used by Potter was found to be rather difficult to prepare so whole lactone milk was substituted. This was whole milk which was thickened by infecting it with *Bacillus acidophilus*. The treatment was found to be very effective. In a very short time the pain in the wound had stopped. Soon thereafter the slough had loosened and

healthy granulation appeared, and healing went on quite rapidly. The amount of the discharge grew less and the fistula had closed 15 days after this treatment was instituted. The treatment was supported by milk and egg enemas, glucose intra-venously and hypodermoclysis of normal saline. The normal saline seemed especially effective in counteracting the toxemia, which was extreme in this case.

CASE 2. Mr. S. N., a white man aged 51 years, had had stomach trouble for about 15 years, which had been diagnosed chronic cholecystitis. The attacks of pain had been very severe, requiring at times grain doses of morphine for relief. The present attack had lasted about 8 hours and the pain had been continuous. He had also nausea and vomiting. The bowels had moved shortly after the attack had started.

The temperature was found to be 103.5 degrees, pulse 120, and respiration 30. The abdomen was extremely tender and rigid and the patient had a peritonitic facies. A diagnosis of acute abdomen, with possibly a gangrenous gall bladder, was made.

At operation the gall bladder was found to be acutely inflamed, and a stone was protruding from the common duct. On account of the severe inflammation present, it was thought best to drain the gall bladder. Soft rubber drains were put down to the common bile duct, after the rent had been sewed up and covered with a piece of omentum. The abdomen was then closed with this drainage in place.

The temperature during the first few days after operation was quite high and the patient was quite toxic. However, the bowels moved and he was getting along fairly well, everything considered. The drains outside the gall bladder were removed on the fifth day when it was noticed that there was some yellow fluid exuding from the wound. The patient complained of an itching and burning sensation in the wound. The next day the skin around the wound was excoriated and some fatty slough was present. The discharge was alkaline in reaction. A diagnosis of duodenal fistula was made and Potter's treatment instituted with whole lactose milk as a buffer solution. Atropine sulphate was given hypodermically every 6 hours in 1/100 grain doses. Supportive treatment of egg and milk enemas were given as well as normal saline intravenously and by hypodermoclysis. The fistula looked better after the first 24 hours and healed uneventfully in 19 days. The amount of discharge in this case was not so large as in Case 1 but it was copious.

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TABLE V.—ASSOCIATED FRACTURES IN OTHER BONES

Sex	Age	Site of fracture in femur	Complicating fractures
M	40	Right junction middle and lower thirds	Head left fibula
M	33	Junction middle and lower thirds	Lower third fibula
M	55	Left supracondylar	Left radius and ulna
F	68	Junction middle and lower thirds	Right ulna
F	30	Left junction upper and middle thirds	Ascending trans pubes, both sides
F	70	Left neck	Right left ulna
M	26	Right junction upper and middle thirds	Both bones right forearm
M	7	Right middle third	Left humerus
M	5	Median condyle	Tuberosity and spine of ulna
F		Lower third	Middle of shaft of tibia and fibula
F	7	Left neck	Right radius
F	70	Junction lower and middle thirds	Skull
F		Left junction upper and middle thirds	Right tibia and fibula lower third (compound)
F		Left neck	Surgical neck left humerus
F	17	Right neck	Ribs
M	40	Junction middle and lower thirds	Left internal maxillary
M	60	Right middle third	Crushing injury to 3, 4, and 5 fingers left hand (amputation) and left leg (amputation)
M	7	Right upper and middle thirds	Right clavicle
M	9	Right junction middle and lower thirds	Left tibia and left radius
M		Right supracondylar	Right scapula
M		Left junction upper and middle thirds	Right clavicle

OPEN REDUCTIONS AND MECHANICAL FIXATION

Twenty two (7 per cent) of the cases had some type of operative procedure performed for the fracture of the femur. Table VIII gives the list of these cases and the operative procedure.

Table VIIIA enumerates the cases of fracture of the neck of the femur which were fixed with screws by Denegre Martin's method.

Cases 13, 14, 15, 16 and 17 enumerated in Table VIII were from our wards. Only 79 (25.6 per cent) cases of fractures of the femur studied in this investigation were treated on our own service. Cases 13 and 15 were both compound fractures. Case 15 was the only instance in which Russell's method used by us in treatment of

TABLE VI.—CASES IN WHICH THERE WERE FRACTURES OF BOTH FEMURS

Sex	Age	Site of fracture in femur	Other complicating fractures
F	74	Both femurs middle third	Left humerus
F	7	Both femurs middle third	
F		Both femurs multiple fractures	
M	9	Both femurs junction middle and lower thirds	
M	7	Both femurs middle thirds	Radius
M	6	Both femurs—right junction upper and middle thirds; left middle third	
M	8	Both femurs—left lower and middle thirds (compound); right middle third	

TABLE VII.—COMPOUND FRACTURES OF FEMUR

Sex	Age	Site of fracture in femur
M	30	Left lower third shaft
M	3	Right middle third
M	5	Left middle third
M	33	Right middle third
M	60	Right middle third (also had crushing injury to left leg (amputation) and three fingers left hand (amputation))
M	31	Right junction upper and middle thirds
M	80	Left middle third (died)
M	40	Junction middle and lower thirds
M		Left junction middle and lower thirds—also two right femur
M		Right femur
M		Greater trochanter (gunshot)

fracture of the shaft of the femur did not give a satisfactory result. (See end-results of fracture of the shaft.)

FRACTURES IN CHILDREN

Fractures of the femur in children are not uncommon. Eighty five (27.6 per cent) of the patients were under 13 years of age. Fractures of the femur in children almost invariably occur in the middle third of the shaft. In 76 (89 per cent) of the 85 patients under 13 years of age the fracture was in the middle third of the shaft. Various methods were used in treating these 85 patients. Overhead traction was commonly used when the child was very young. Russell's method was also frequently employed. Reduction and immobilization in plaster and Buck's extension were also employed in some instances.

TABLE VIII.—OPEN REDUCTION AND MECHANICAL FIXATION

Sex	Age	Site of fracture	Operative procedure	Ultimate result
1 M	6	Left middle third shaft	Open reduction	Perfect result
2 M	10	Right middle third shaft	Open reduction	Unknown
3 M	12	Middle third shaft	Open reduction	On diaphysis—union with shortening
4 M	2	Middle third shaft	Open reduction	Perfect
5 M	12	Shaft middle third	Former open reduction and fixation with plate. Plate removed	Unknown
6 F	60	Middle third shaft	Open reduction	Pneumonia—death
7 F	25	Middle third shaft	Fixed with Lane plate	On diaphysis—angulation
8 F	20	Middle third shaft	Open reduction	Infection—osteomyelitis
9 F	3	Middle third shaft	Fixed with Lane plate	Death. Cause not stated
10 F	43	Middle third shaft	Fixed with Lane plate	Union with shortening
11 F	17	Right shaft (left femur also)	Fixed with steel plate	Alignment good but stiffness right knee
12 M	5	Lower third shaft	Fixed with Lane plate	Perfect
13 M	20	Left shaft middle third	Fixed with metal band	Died. Cause not stated
14 M	13	Epiphyseal separation head	Reduction and suspension in Russell's apparatus later wedge osteotomy	Unknown
15 M	1	Middle third shaft	Open reduction after failure to secure reduction by Russell's method	Unknown
16 M	5	Old fracture non-union middle third	Bone graft from tibia	Union
17 M	50	Lower third shaft	Lane plate	Union. Plate removed

This case was operated upon in another hospital

TABLE VIII.—DENFEGRE MARTIN FIXATION OF FRACTURE OF FEMORAL NECK

Sex	Age	Site of fracture	Operative procedure	Ultimate result
18 F	76	Right neck	Fixation with 2 screws	Union—shortening—stiffness limp
19 F	66	Right neck	Fixation with 2 screws	Slight shortening. Leg stiff at times
20 F	56	Left neck	Fixed with screws	On diaphysis no union but good position with screws holding
21 F	69	Right neck	Fixed with screws	Non-union. Later head was removed and trochanter placed lower on shaft
22 M	32	Left neck	Fixed with screws	On diaphysis screws in good position

The result in children is almost always good regardless of the method used. We were able to follow up 28 cases of fracture of the femur in children under 13 years of age. Twenty three of these received a perfect result with no shortening, no weakness, no limp or residual of any kind. Of the 5 remaining, one has shortening and a limp, 3 patients report limping but have no shortening. One of these was a patient in whom there was a fracture in each femur, one of which was compound. This patient still has a draining sinus. One patient reported a limp, weakness of the knee and occasional stiffness with pain. Union was good without shortening.

MORTALITY

There were 22 hospital deaths, a mortality rate of 7.14 per cent. Pneumonia accounted for 10 of these deaths and possibly an eleventh. Disorientation and delirium in the aged resulted in three deaths. Fractured skull and cardiac failure in an asthenic man, uremia, and pulmonary embolism (questionable) accounted for one death each. The cause was not determined in four instances. There were 8 cases of intertrochanteric and six cases of fracture of the neck, among the 22 patients who died. This high death rate in cases with fractures of the neck and intertrochanteric region of the femur may be accounted

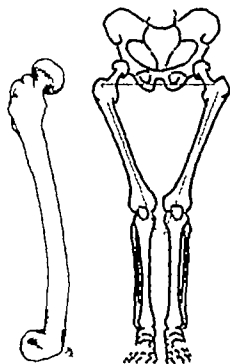


Fig. 1 left. In the lateral view the normal femur is bowed convexly forward.

Fig. 2 The triangle formed by the femur.

for by the advanced age of the patients in this group. The mortality rate in this series for intertrochanteric fractures is 14.5 per cent and for fractures of the neck of the femur is 10.9 per cent.

ANATOMICAL CONSIDERATION

In viewing the femur from the standpoint of normal contour, one is impressed with several striking points in its conformity. In the lateral view it is obvious that the normal femur is bowed convexly forward (Fig. 1). It is important to preserve this bow because if it is decreased or increased, it will result in the weight bearing line of force falling either posterior or anterior to its normal position in the foot. Viewing the femur anteroposteriorly the shaft again is bowed slightly with the concavity inward. When the individual is standing erect or lying supine with the heels together the shaft of the femur passes downward and inward from the greater trochanter and each femur may be regarded as part of a side of an isosceles triangle whose base is formed by an imaginary line between the trochanters and whose apex is at the intersection of lines projected below the knee in the direction of the shaft of the femur (Fig. 2). The neck of the femur usually joins the shaft at an angle of about 125 degrees. Decrease

in the angle results in a varus deformity with the effect of shortening of the femur and tilting of the pelvis toward the affected side to compensate for the deformity.

Whatever may be said for the contention that the ultimate end in the treatment of fractures is perfect functional result, the proximal aim in the treatment must be directed toward attaining a perfect anatomical result and by this a perfect functional result may be obtained. In fractures of the femur as in other bones of the body it is most desirable to have perfect apposition of fragments without angulation or shortening. By careful attention to detail and repeated checks on the alignment, we have found that this can be obtained very often indeed.

Muscles play a very important part in position of fragments in fractures of the femur gravity a no less important rôle. These two forces must be satisfied to obtain and maintain correct apposition and alignment of fragments. The usual displacement varies considerably depending on the level of the fracture. The displacement at different levels is more or less characteristic in fact, almost constant, with the necessary exceptions to justify the generality. When such is the case, it is due to more constant forces such as gravity and muscle tone and not to the extreme variable—the direction of the fracturing force.

When the fracture is in the neck of the femur the upper fragment is still attached by the ligamentum teres and the vacuum force of the acetabulum. The muscles running from the pelvis to the leg exert a shortening action while the external rotators with the force of gravity combine to carry the trochanter back and externally rotate the shaft. The same forces act in a similar manner on the lower fragment when there is an unimpacted intertrochanteric fracture. Here the capsule of the joint may also assist in holding the upper fragment in position.

If the fracture detaches the lesser trochanter this fragment may be displaced upward and forward by the iliopsoas. If the greater trochanter is broken off the gluteus medius and minimus, pyriformis, gemelli, and obturator internus tend to displace it upward and backward.

In a peritrochanteric fracture, one passing transversely across the shaft between the two trochanters, the upper fragment is abducted and externally rotated while in a subtrochanteric fracture, the additional action of the iliopsoas on the upper fragment tends further to rotate it externally and flex it. In fractures in this region as in fractures at other levels across the bone upward displacement of the lower fragment is prone to

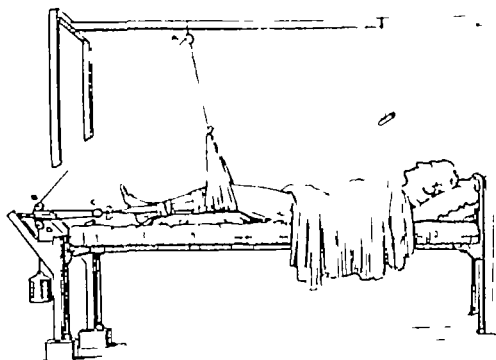


Fig. 3 Russell's method (From Russell, Brit J Surg 1924 li 491)

occur due to the action of the muscles bridging the line of fracture. In securing alignment in per trochanteric and subtrochanteric fractures and fractures of the upper part of the upper third of the femur we believe that the lower fragment must be brought in line with the prereluction position of the upper fragment, i.e. into abduction whereas we do not believe that the lower fragment should be brought in the line of the prereluction position of the upper fragment if it is abducted in fractures in the lower part of the upper third the middle third or the upper part of the lower third of the shaft as we shall show.

In fractures of the shaft the lower fragment is almost constantly displaced posteriorly and upward with relation to the upper fragment and this is partially due to the action of gravity, partially to the tone of the gastrocnemius and popliteus and plantaris muscles flexing the lower fragment on the leg while the muscles bridging the site of fracture produce shortening. Moreover the adductor muscles are of the greatest importance in fractures of the shaft. The strong adductors tend to displace the fragments inward and they exert a more decided effect on the lower fragment since in the upper fragment adduction is opposed by the attached abductors. The adductor longus pulling up on the adductor tubercle tends to shorten the distance between the inner condyle and the pubic ramus. Abductors tend to abduct the upper fragment and thus an angulation with the convexity outward is often produced es-

pecially when the fracture is in the middle of the shaft. To overcome this angulation and to secure sagittal alignment, it is practically and even theoretically incorrect to carry the lower fragment into the prereluction line of the upper fragment, i.e. abduction. On the contrary the leg and lower fragment must be carried into adduction to relax the muscles which are producing the deformity. In a number of cases we have proved this repeatedly to our satisfaction that to correct external angulation of the femur in fractures of the shaft, the leg must be carried into adduction. Abduction only increases deformity. This sagittal alignment is easy to correct and maintain it is only shortening and posterior displacement of lower fragment which offer any difficulty.

In supracondylar fractures the lower fragment is flexed on the lower leg and upwardly displaced. Here gravity again and the gastrocnemius, popliteus, and plantaris each play a part in producing the posterior displacement. Muscles bridging the fracture effect the shortening. T or Y fractures into the knee joint are in effect supracondylar fractures but with the added complication of involvement of the joint and some times of separation of the condyles.

Fractures of single condyles may or may not be attended with displacement. Here muscles play less a rôle and the resulting displacement is largely the result of the fracturing force.

In epiphyseal separation at the lower epiphysis of the femur, the lower fragment is generally

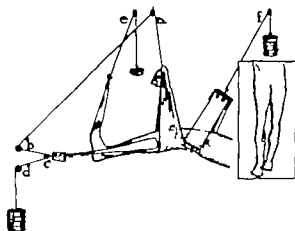


Fig. 4. Modified Russell's method. The upper band is added to correct posterior displacement of the lower fragment.

anteriorly displaced and is flexed on the lower leg. Why the anterior displacement occurs is hard to explain, but so frequently was this lesion produced by a particular force e.g. a boy getting his leg caught in the spokes of a wagon that it became known as a cart wheel fracture and in absence of a better explanation, the fairly constant displacement may be attributed to the particular fracturing force.

METHODS OF TREATMENT

In this series various methods of treatment have been used. In the other fracture services of Charity Hospital the routine differs from the methods used in our wards. We shall however outline only the routine and the methods used in our service. Seventy-nine of the 308 cases reported in this article were treated in our wards. Anatomically these 79 fractures were divided as itemized in Table IX.

Modification of Russell's method in treating fractures of the shaft of the femur. In 1924, Russell of Melbourne described his method of treating fractures of the femur. We believe that this is the method of choice in treating fractures of the upper middle, and lower thirds of the shaft of the femur above the supracondylar region and below the subtrochanteric region. The method is intended to rest the muscles in their most accustomed position and by a combined pull on the knee and the lower leg to exert a force on the lower fragment of the femur in the normal line of the shaft (Fig. 3). A bath towel is placed under the popliteal space. To suspend the leg at the knee by this towel, a rope passes up and around a pulley A from which pulley a perpendicular dropped

TABLE IX.—ANATOMICAL CLASSIFICATION

	Cases
Epiphyseal separation head.	1
Neck fractures	15
Intertrochanteric fractures	20
Greater trochanter	1
Subtrochanteric	3
Shaft	31
Supracondylar	3
Supracondylar T	3
Not classified	2

79

would fall just below the tubercle of the tibia. Thence the rope passes around pulley B on the foot of the bed and back and around pulley C which is attached to a spreader separating lateral strips of adhesive applied to the sides of the lower leg. Then the rope passes back and around pulley D which is just below pulley B on the foot of the bed. A weight of 8 pounds (for adults) is fastened to the end of the rope. Russell emphasized the necessity of putting the leg into a position which is most natural for the muscles. He recommended the use of a pillow under the knee and the thigh to counteract posterior displacement of the lower fragment.

The only difficulty encountered was the tendency to persistent displacement of the lower fragment and one of us instituted the use of the upper band shown in Figure 4 to overcome this. This band is made of canvas and is separated from the skin of the thigh by cotton. It is suspended on either end by hooks on a 1 by 1 inch piece of wood the length of which is the width of the canvas. From the center of this strip of wood, a rope passes up and cephalad around a pulley and 10 pounds of weight are placed on the end of the rope. This last pulley should be placed so that the pull is perpendicular to the thigh.

We use Blake's foottrap to prevent foot drop. As far as rotation is concerned it is hardly necessary, for as Russell has said the towel under the popliteal space prevents this undesirable displacement.

To secure alignment in the anteroposterior view when the fracture is in the middle or lower third of the shaft, the leg is carried into adduction across the midline. This invariably has the desired effect and one should not be beguiled, when the upper fragment is in more abduction than the lower into attempting to bring the fragments into alignment by further abducting the lower leg. It seems paradoxical but correction here is obtained by bringing the lower fragment away from the line of the upper, i.e., to adduct the whole leg. This re-

Alfred Bradburn.

laxes the adductor muscles which produce the deformity. When the fracture is in the upper part of the upper third of the shaft, i.e. almost in the subtrochanteric region, the leg must be abducted. Here the abductors have control of the upper fragment and the lower fragment must be brought into the prerotation line of the upper fragment.

It is desirable to institute immediate treatment in fractures of the femur. Examination should be done at once, an X-ray should be taken immediately and when the nature of the injury has been ascertained to be a fracture of the shaft of the femur and Russell's is the method selected for treating the leg should immediately be suspended in the apparatus. Morphine may be given but an anesthetic is not necessary. We have found that when delay is encountered some difficulty may be had in overcoming shortening and displacement. Shock does not contra indicate the application of the apparatus. Occasionally we have found it necessary to use more than 10 pounds on the lower hook up for a few days especially if the individual is very obese or very muscular. This weight must be reduced after correct position is obtained otherwise overextension may result and persistent overextension is to be avoided.

Repeated X-ray examinations are necessary, especially during the time perfect alignment is being secured. At the end of 4 days the fragments should be in perfect alignment but this sometimes means several adjustments of the apparatus to secure changes in position.

We keep our adult patients in this form of traction about 8 weeks, adolescents about 6 weeks. Toward the latter part of this period, the patient is measured for a Thomas walking caliper brace, which is applied immediately when the traction is removed. The patients wear the brace day and night for 1 month they take it off at night but continue to wear it when walking until from 5 to 6 months have elapsed from the time of the injury. They should remove the shoe daily, wash the foot, and put on a clean pair of socks. They are instructed to keep the knee hinge locked when they are walking and to open it each time they sit down. Moreover, they are instructed to sit on a table each day and work their leg with a muscle exerciser attached in order to mobilize the knee (Fig 5).

Fractures of the shaft The technique we use has secured excellent results in our hands. In this series there were 31 cases of fracture of the upper, middle, or lower thirds of the shaft of the femur admitted to our service. One was a compound fracture on which an open reduction was done and the fragments were fixed with a Lane plate. Sub-

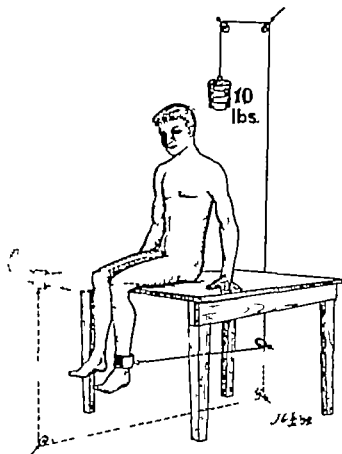


Fig 5 A method of mobilizing the stiff knee after fracture of the femur. The dotted outline represents stiffness in extension.

sequently the plate had to be removed. The end result is not known. One was an old fracture of the shaft with non union. A bone graft was done and union resulted. Three of the patients transferred to other hospitals and were thus not treated entirely by us. One of these patients was treated by Russell's method in the other hospital. The result was unsatisfactory and an open operation was done. One patient 80 years of age had a compound fracture and an open operation was done immediately. This patient died. The 25 remaining were treated by the modified Russell method described herein. Two died. One, a patient 68 years old developed diarrhea and delirium and died and one aged 71 years died from a cause recorded as bronchitis. In none of the remaining 23 cases was it necessary to do an open operation. We have been able to follow up 9 of the 23. 7 of the 9 obtained a perfect result with no lump, no shortening, no stiffness and no weakness. Another wrote that he had a perfect result with no shortening, no stiffness, but he also stated that the muscles of the affected leg were a little weaker than of the other leg. He attributed this to disuse and said the strength of the limb

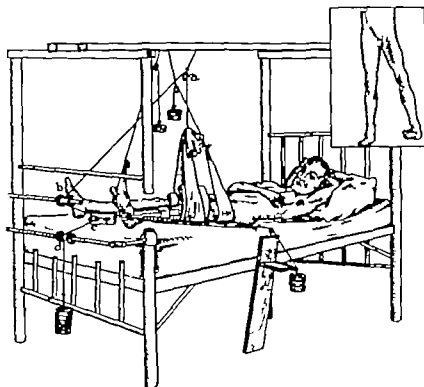


Fig. 6 Modified Russell's method used in treating intertrochanteric fractures of the femur. The leg is abducted and internally rotated.

was improving. The ninth patient replied that his result was not exactly perfect, that his leg was strong and he did not limp, but that he had some stiffness of the knee and the affected limb was about one inch shorter than normal. An X-ray picture taken before dismissal from the hospital showed good position with callus.

Fractures of the neck of the femur. Whitman's method has probably given the highest percentage of good results in the treatment of fractures of the neck of the femur. We have used a method modified from Russell's traction in the treatment of these fractures. So far we have not employed it in a sufficient number of cases to report on its efficiency.¹ The application of the Russell apparatus in treating fractures of the neck of the femur makes the patient far more comfortable than if he is encumbered with a cast. The apparatus is applied in the usual manner but the leg is carried into marked abduction by swinging the lower pulleys out (Fig. 6). The leg also is rotated internally by an adhesive band which is started on the lateral aspect of the leg and runs

up and in and around the leg. It is faced with another piece of adhesive where it comes in contact with the posterior aspect of the limb and from this adhesive a rope passes out and around a pulley. Six pounds are attached to the end of the rope. It is essential to attend diligently to the adhesive straps and replace them with fresh ones at the first signs of slipping.

In the elderly individual, we screw the fragments together with two wood screws after the method described by Denegre Martin. The necessity of getting the elderly patient out of bed is paramount. Approximating the fragments with wood screws is a relatively simple operative procedure and may be done under local analgesia with little discomfort to the patient. The operation does not expose the fracture or open the joint. Two drill holes are made in the external surface of the femur just beneath the greater trochanter. The drills, just a little larger than the unthreaded shank of the wood screw, are directed toward the head through the medullary portion of the neck of the femur. They only drill through the cortex. The screws may be pushed up to the head of the femur without resistance. They grip the detached head and with free rotation of the unthreaded

Since this paper was submitted for publication we have used this method in 4 cases and now-men resulted in each instance. From our experience we would condemn the method in the treatment of fractures of the neck of the femur.

portions of the shank in the drill hole the screws approximate the head to the distal fragment (Fig 7). If the patient is not too sick we perform the operation within 24 hours after admission. We have used this method recently in middle aged individuals with excellent results. They are permitted out of bed in 3 to 5 days but are not allowed unsupported weight bearing on the affected limb until union is complete.

Intertrochanteric fractures of the femur Intertrochanteric fractures are closely related to fractures of the neck of the femur. The prognosis as regards union is better in intertrochanteric than in fractures of the neck of the femur. Intertrochanteric fractures are extracapsular which makes a decided difference due in great part we believe to the fact that the fracture line is not bathed with synovial fluid. Synovial fluid seems to interfere with union—a factor which we are attempting to prove experimentally in dogs.

In intertrochanteric fractures we use the same methods given for fracture of the neck of the femur. We have had enough experience to say that Russell's apparatus yields excellent results (Figs. 8 and 9), and at the same time keeps the patient comfortable. The leg must be abducted and internally rotated. Martin's method is also of decided value in the treatment of intertrochanteric fractures and as many of these patients are old, we sometimes use it.

Pertrochanteric fractures of the femur In the pertrochanteric fracture of the femur the upper fragment is generally markedly abducted and externally rotated. Russell's method is applicable in the treatment but the lower fragment must be brought in line with the upper and therefore the limb is carried into abduction and is externally rotated by lateral skin traction applied in a manner analogous but in an opposite direction to that used in securing internal rotation in fractures of the neck of the femur.

Subtrochanteric fractures In addition to being abducted and externally rotated as in pertrochanteric fractures the upper fragment in a subtrochanteric fracture is under the additional influence of the iliopectineus muscle and may be markedly flexed. Russell's apparatus is still applicable in these cases but the pulleys at the foot of the bed should be elevated to produce flexion of the hip. In treating this fracture however we prefer to use a Steinmann pin Kirschner wire or calipers at the lower end of the femur to obtain skeletal traction.

Fractures of the greater and lesser trochanters When the greater trochanter is fractured, there may or may not be displacement. If displacement

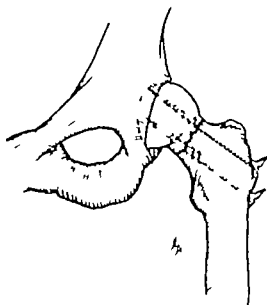


Fig. 7 The use of wood screws to approximate and fix the fragments in fracture of the neck of the femur. Denegre Martin's method.

is not present it is sufficient to put the patient at rest immobilizing the leg for 6 weeks. Suspended traction is much more comfortable and just as efficient as immobilization in a cast. When separation is present it is generally characterized by upward and backward displacement of the trochanter and the limb is put in a position of abduction external rotation and flexion at the hip. Here again we prefer suspended traction with the Russell apparatus to immobilization in a cast.

When the lesser trochanter is fractured it may or may not be separated from the shaft. If separation is not present immobilization for a period of time sufficient to permit union is all that is necessary. When separation is present, it is characterized by forward and upward displacement of the trochanter by the iliopectineus. Approximation of the fragments can be best secured by flexing and externally rotating the thigh and the limb is immobilized in this position by skeletal traction or by a plaster spica extending from the nipple line to and including the foot.

Epiphyseal separations of the femur Separation of the epiphyses is fortunately rare. When separation of the upper epiphysis occurs it is of immediate effect comparable to the fracture of the neck of the femur. However the remote effects differ because of the age of the patient. It is essential to secure exact reduction. This is attempted under anesthesia and if successful, the limb is maintained in abduction and internal rotation by the use of Russell's apparatus applied in the manner described for fractures of the neck



Fig. 8. Intertrochanteric fracture on admission in Thomas splint.



Fig. 9. Union intertrochanteric fracture in good position. Same case as shown in Figure 8 after treatment by modified Russell's method (Fig. 6).

of the femur. The apparatus is removed after 6 weeks. The youth is allowed to bear weight unsupported after 6 to 8 weeks. Open reduction is to be resorted to if success is not achieved by the closed method. Replacement of the conical upper end of the diaphysis in the concavity of the upper epiphysis is the end in view. Excision of the upper epiphysis is reserved for long standing cases in which traumatic arthritis has developed and a satisfactory functional result otherwise seems impossible.

When the lower epiphysis is separated from the shaft, immediate reduction under anesthesia should be accomplished. The limb is immobilized in a plaster cast in the position of flexion at the knee. After 3 weeks, the cast is bivalved and daily gentle motion is begun. After 6 weeks, the patient may be permitted supported weight bearing.

Supracondylar fractures of the femur. We have used Russell's apparatus in treatment of supracondylar fractures of the femur and have found the method unsatisfactory in these fractures. Here there is marked posterior displacement of the short lower fragment. It is flexed on the lower leg. Russell's apparatus does not permit the degree of flexion of the knee necessary. In these cases to secure proper alignment of the fragments. Too frequently posterior displacement of the lower fragment persisted when we used Russell's method. Therefore we have discarded this method and are using skeletal traction with satisfactory results. The method is shown in diagram in Figure 10. Traction is obtained by

passing a Steinmann pin through the tibia just posterior to the crest and just below the tubercle. A well padded double inclined plane is placed under the leg with an obtuse apex angle of about 115 degrees. The boards are so arranged that the apex presses up on the lower fragment. From the horseshoe attached to the Steinmann pin in the crest of the tibia a rope passes down and over a pulley on the foot of the bed. This pulley must be at such an elevation that it is below the level of a line projected from the shaft of the femur. In other words, the pull is so directed that the posteriorly displaced lower fragment is pressed up by the apex of the double inclined plane. In adults, 25 pounds for 36 to 48 hours are necessary to secure reduction; then the weight is reduced to 15 pounds to maintain the position. The patient is maintained in this apparatus until mild union is obtained (5 to 6 weeks) and then Russell's apparatus is substituted and the patient remains in suspended traction for an additional 3 or 4 weeks. The after treatment is similar to that used in fractures of the shaft of the femur.

Fractures of the lower end of the femur into the knee joint. Fractures of the lower end of the femur into the knee joint are closely allied to supracondylar fractures of the femur. If there is marked separation of the condyles, we attempt to overcome this by use of the Boehler screw clamp. If this is not successful, a wood screw is used to approximate the fragments. The injury is then treated as a supracondylar fracture. If the frac-

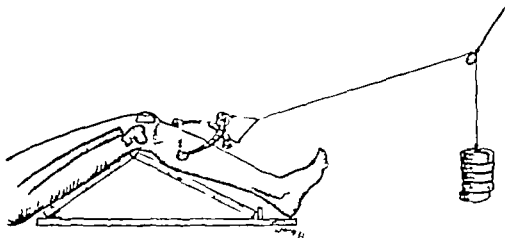


Fig. 10 Method used in treating supracondylar fracture of the femur. The line of traction is below a line projected from the femur and the apex of the doubly inclined plane presses up on the lower fragment.

ture is complicated by hemorrhage into the knee the bloody fluid is aspirated and the joint is lavaged with normal saline. This is repeated as often as is deemed necessary.

Fracture of a single condyle. In fractures of the condyles there is no displacement of the fragments. Fixation in a plaster cast is an adequate method of treatment. Here synovial fluid we believe is prone to delay union and no non-supported weight bearing is permitted for 4 to 6 months. When there is displacement of the fragments, reduction may be accomplished by manipulation of the fragments when the patient is under anesthesia but if this is not successful longitudinal traction on the leg with lateral bands to correct varus or valgus or open reduction and fixation with a wood screw is resorted to.

END-RESULTS

It is to be remembered in reading these results that the patients were treated by many different men using a variety of methods.

It was very difficult for us to follow the class of patients reported in this paper. They are the poorest people of the city and state not infrequently uneducated, frequently unintelligent, and often they change their addresses. Consequently, as would be expected the percentage of those we were able to follow to determine the end results is low. We sent out questionnaires to all those patients who were dismissed from the hospital. We asked if they had a perfect result or if they had lump, weakness, stiffness, shortening, union or non-union, and also how long it took them to get over the disability resulting from the fracture. We received 84 replies. Twenty-eight of these were from patients who were under 13 years of age at the time they were admitted to the hospital.

As already stated the middle of the shaft was the part usually affected in children. Twenty three (82 per cent) of the 28 replies received from the children showed that the child had a perfect result with no residual of any kind whatsoever. The 5 remaining were partially disabled. It is remarkable what powers of repair and compensation are ready in youth to overcome the injury. One of these children had union with overlapping and shortening of a centimeter to a centimeter and a half at the time of dismissal and now has a perfect result with no residual of any kind. In the growing child the shortened bone may grow faster than that of the opposite leg so that the asymmetry is overcome.

From patients over 12 years of age at the time of the injury we received 56 replies. These are tabulated in Table V. In computing the results we considered as totally disabled those patients who were confined to bed or who had still to use a brace or crutches or both as partially disabled patients who could walk but who had some residual, limp, stiffness, shortening, weakness, etc. and as perfect results, only those patients who had absolutely no remaining evidence of the former fracture.

Supracondylar fractures and subtrochanteric fractures show the greatest percentage of imperfect results. Replies from 4 patients with supracondylar fractures and one with supracondylar T fracture show that 2 of the 5 are totally disabled, 2 are partially disabled and only 1 had a perfect result.

Both of the 2 patients with subtrochanteric fractures who replied had imperfect results with limp and shortening.

Only 3 (23 per cent) of 13 patients with fractures of the neck of the femur had a perfect result.

TABLE A.—RESULTS OF FRACTURES OF THE FEMUR IN PATIENTS OVER TWELVE YEARS OF AGE

Location of fracture	Repairs	Perfect results	Imperfect results	Totally disabled	Back-lam	Partially disabled	Patients not healed					
							Patients having limp	Patients having weakness	Patients having stiffness	Patients having non-union	Patients having shortening	Nerve paralysis
Neck of femur	3	3		4		6	20	9	3	1	3	
Intertrochanteric	14					3	6		3	1	7	
Subtrochanteric												
Upper third shaft												
Middle third shaft	9		3			3	6		6			
Lower third shaft												
Separately hit			3								3	
Separately hit T												
Single cordyle												
Epiphyseal separation												
Unknown												
Total	28		14	7		3	7	7		5	11	

Five (38 per cent) are totally disabled and 5 (38 per cent) are partially disabled. Four (30.7 per cent) report non union. One patient with fracture of the neck of the femur died after leaving the hospital. This case is not included in the computations of end results.

Intertrochanteric fractures show a higher percentage of good results. Four (28.6 per cent) of 14 patients had a perfect result. Two (14 per cent) are totally disabled. Eight (57 per cent) are partially disabled.

Twenty-one patients with fractures of the shaft of the femur responded. One of these had a fracture in the upper third, one had a fracture in the lower third of the shaft. Both of these patients had a perfect result. The remaining 19 had fractures in the middle third of the shaft of the femur. Of these 21 patients, 13 (62 per cent) had perfect results, none is totally disabled, 8 (38 per cent) are partially disabled.

SUMMARY

Three hundred and eight cases of fracture of the femur received treatment in the wards of Charity Hospital, New Orleans, from June 1, 1929 to May 31, 1931. One hundred and ninety-two of the patients were males, 115 were females (167.1) and the sex could not be determined from the record of one. Seventy-nine of the patients were on the author's service.

The first decade of life was the decade most often affected, there being 70 cases in our series. Thirty-six per cent of the patients were under 20, 41.88 per cent were 50 years or older.

The shaft of the femur, especially of the middle third, is the most common site of fracture in the first and second decades of life, the intertrochanteric portion and the neck are the sites more commonly affected after 50 years of age.

Although there were fewer females than males in the entire series, there were proportionately more women than men with fracture of the neck of the femur and with intertrochanteric fractures.

Nine per cent of the cases were complicated by fractures in other bones. Two and twenty-seven hundredths per cent of the cases had fractures in both femurs.

In 3.6 per cent of the cases the fracture of the femur was compound.

Nerve injury was uncommon. It occurred once but was the result of the treatment instead of the fracture.

Fracture of the femur in children occurs almost always in the middle third of the shaft. The results were almost always excellent, in spite of a variety of methods used.

In 22 of the 308 cases of fracture of the femur some sort of operative procedure was done.

The mortality rate for the 308 cases was 7.14 per cent for intertrochanteric fractures alone, 14.5 per cent, and for fractures of the neck of the femur, 10.9 per cent.

The methods we prefer are briefly described. In treating fractures of the shaft of the femur Russell's method with slight additions is our choice. In treating fractures of the intertrochanteric region, we also use a modification of Russell's method.

Eighty four replies were received from the questionnaires sent to the patients. Twenty eight replies were from children under 13 years of age at the time of their admission to the hospital 23 or 82 per cent, of these received perfect results. Fifty six replies were received from patients over 12 years of age at the time of their admission to the hospital. Those with fractures of the shaft of the femur show the best results (62 per cent perfect). Patients having fracture of the neck of the femur showed 23 per cent perfect results 36 per cent are totally disabled and 38 per cent are partially disabled. Thirty and seven tenths per

cent have non union. Twenty-eight per cent of 14 patients with intertrochanteric fractures had perfect results. Fifty seven per cent are partially disabled and 14 per cent are totally disabled. Fifty per cent of 5 patients with supracondylar fractures have persistent disability.

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RENAL COMPLICATIONS OF BILIARY TRACT INFECTIONS

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IN 1928 the occurrence of acute nephritis with suppression of urine as a complication of severe biliary infection was forcibly called to our attention (Case 1). Since that time we have customarily estimated all cases of gall bladder disease from the standpoint of renal function. Meanwhile we have seen renal failure in 5 more patients (Cases 2 3 4 6 12) and have found a similar case history (Case 5) in our records of less recent date. The occurrence of so grave a renal complication in 6 of these 7 cases of a total of 56 patients with disease of the biliary tract under the care of my father and myself since Case 1 is certainly not a common experience in the practice of most surgeons. It is an indication of the fact that we at least, have to deal with very sick individuals, particularly during times of economic stress (2). The fact is that singularly few clinicians have concerned themselves with the possibility of renal failure in biliary infection whereas the chances for permanent damage to the liver pancreas and heart are fairly generally appreciated. Judd reported before the Section on General Surgery of the American Medical Association in 1932 an incidence of circulatory system disease over 50 per cent higher among patients with surgical diseases of the biliary tract than was the incidence for the age group according to the statistics of life insurance companies.

The majority of the few cases reported has been in the German literature. Clairmont and Haberer in 1911 presented 5 cases of renal failure occurring after operations on the biliary system 2 patients recovered. The presentation of the individual cases is so incomplete that a critical evaluation of them is difficult. Pre-operative urine findings were normal in 1 case and were indicative of kidney damage in another. The occurrence of jaundice was constant, but postoperative bile drainage is mentioned only once. All patients but one were subjected to cholecystectomy and choledochostomy under chloroform anesthesia. No indication is given of the competency of the circulation to maintain output of urine and it seems probable that in only 1 of the 3 fatal cases was suppression of urine due to nephritis. These authors did not succeed in producing anuria experimentally by ligation of the common duct in dogs though renal function by dye excretion sometimes showed im-

pairment. They concluded that the dog was not a useful experimental animal for the purpose, that anuria was always the result of parenchymatous damage in clinical cases of deep jaundice, and that surgeons might have to content themselves with cholecystectomy in such patients. In the same year Steinthal mentioned having seen such a case in which anuria developed on the fourth day after operation with death and characteristic autopsy findings of acute tubular degeneration. He considered that the anesthetic had been the precipitating factor there having been a latent renal insufficiency as a sequel of liver damage. Beck and Simon also reported having seen such cases die in uremia without operation. Staeheli in 1921 presented a case of his own, the patient dying anuric 3 days after cholecystectomy and choledochostomy there had been albumin in the urine before operation autopsy showed petechial hemorrhages into all the organs. He reviewed 3 of the cases of Clairmont and Haberer and a case of Kehr's, that of a 65 year old man, jaundiced who put out only 300 cubic centimeters of urine before death 4 days after cholecystectomy autopsy in this case showed only jaundice of all organs and arteriosclerotic kidneys. Staeheli believed anuria to be the sum of many factors, most prominent of which are long duration of disease, infection, and deep jaundice. As for the effects of anesthetics, acute yellow atrophy of the liver was not found at autopsy in any of the cases reviewed and tubular necrosis (attributable to ether) in only one. In common with the previously quoted authors, he postulated a primary liver failure to detoxify substances which then damage the kidneys. He recommended careful functional tests of the kidneys before operation and urged early operation in acute severe cholecystitis to avoid renal complications. With the latter recommendation we must heartily disagree not simply for the reasons ordinarily urged, but because of evidence on this particular problem to be presented later. Abrahamson reported studies of renal function in 15 cases of jaundice due to various causes. None of his cases showed evidence of renal insufficiency (retention of nitrogen, salt, or water) and he felt that there was no significant change in the ability of his patients to excrete phenolsulphonephthalein. However he has included as normal one case in which

phenolsulphonephthalein excretion was 15 per cent, 2 in which it was 40 per cent one of 45 per cent (all in 2 hours after intramuscular injection) and one in which it was 40 per cent 2 hours after intravenous injection. Two of these patients had albumin and hyaline and granular casts in the urine. We do not consider these normal figures for phenolsulphonephthalein excretion in patients ranging from 23 to 50 years of age. It is our opinion that only 6 of his 15 patients showed really satisfactory dye excretion (60 per cent after intramuscular injection in 2, 60 per cent in 1 and 65 per cent in 3 after intravenous injection). Abrahamson urged quite properly that if dye excretion were low extensive operation was to be guarded against whereas a normal dye excretion offered some assurance that postoperative renal failure was unlikely to occur. With certain exceptions to be discussed later we quite agree to these proposals.

Wilensky and Colp made observations on the nitrogen partition of the blood in a large series of patients with biliary tract disease before and after operation in many cases some of these patients had evidence of nephritis though it is not made clear that any of them developed suppression of urine. The many observations in their last two papers are valuable material from which to draw conclusions though the conclusions to which we have come from a study of their figures differ widely from those of the authors. It is necessary to be specific in the discussion of these papers.

In the second paper Table I lists 56 cases of biliary tract diseases without jaundice or other complication and with normal blood nitrogen figures in all. Table II contains 13 "mild and moderate cases with jaundice but without demonstrable kidney involvement or other complication." Four cases have blood non-protein nitrogen values of 50 (4 cases), 62.9 and 71.7. The authors consider all of these as being within normal limits, apparently explaining the 2 last figures as being probably due to excessive nitrogenous intake in diet and conclude that varying degrees of jaundice "in the absence of kidney complications apparently do not influence the blood figures for non-protein nitrogen." Table III comprises 8 cases of mild and moderate biliary tract disease with or without mildest albuminuria and a minimal number of casts. Only one of these patients was jaundiced they are commented on as having no nitrogen change although 3 cases had non-protein nitrogen values of 49, 57.7 and 60.1. Table IV lists the findings in 9 cases with proved structural liver changes and it is the authors' comment that no particular change in blood nitrogen is noted. In the 2 patients who died, however non-protein nitrogen was 60 in one and uric acid was 5.3 in the other (non-protein nitrogen not determined). That the objections raised to the authors' deductions from pre-operative observations in the foregoing tables are valid is also borne out by the later behavior of the 8 patients (Cases 39, 49, 52, 75, 80, 81, 82, 83) in question when one follows them

in Tables V and VI of the second paper and in Table III of the third paper. In Cases 39, 52 and 83 apparently no operation was done. Case 49 has no postoperative determinations recorded, Cases 75, 80, 81 and 82 patients died after operation the first with a falling the third with a rising non-protein nitrogen and no postoperative determinations on the others. The 4 postoperative deaths among these 5 patients operated on occurred in patients who were not jaundiced, 3 of them being in acute attacks of gall stone disease and the fourth just after an acute exacerbation. Further figures of value are given in Table V of the second paper which deals with comparisons of pre-operative and postoperative blood nitrogen. A large increase occurred in 18 per cent of the cases reference to previous tables shows that this occurred, with one exception in cases operated on during an acute attack. The author reports 18 per cent of cases showing a decrease following operation (Cases 3, 54, 58, 57, 77) but in the first 3 cases the difference ranges from 0.8 to 2.4 milligrams per 100 cubic centimeters, approximating the limits of error of the method. Case 75 patient died although the non-protein nitrogen fell from 60 to 40. Case 77 patient's pre-operative non-protein nitrogen was 44.4, is variously listed as having a postoperative value of 33.3 in Table V and of 66.5 in Table XVI where it appears with the cases classified as having both jaundice and nephritis.

There is in general much difficulty in reconciling the authors' comments in their text with the figures that appear in their tables. It is obvious that they have not recognized that retention of nitrogen occurs in some acute exacerbations of cholecystitis whether previous attacks have occurred or not, in the absence of jaundice and perhaps with normal urine. Their clinical observations however have impressed them with the importance of jaundice in causing renal lesions subsequent to hepatic cell damage and with the further effect of anaesthetics notably ether on an organism that is perhaps barely compensated previous to operation. We must disagree sharply with their observation that the simplicity or severity of the operation itself is of little consequence. Any important lowering of the alkaline reserve as a result of anaesthesia or operative trauma should seriously threaten a precarious liver and kidney function. The fact that of the 18 cases these authors classify as having been severely sick the 6 postoperative deaths and the 2 non-operative deaths occurred in acute cases should be ample indication of how poorly acutely sick patients withstand an added surgical insult.

Walters and Parham reported 2 patients dying of renal insufficiency, one before the other after operations for the relief of jaundice. They made the observation that following ether anaesthesia the blood nitrogen sometimes doubled in amount on the second and third postoperative days. They differentiated clearly between hepatic and renal insufficiency in these complicated cases

associated with the former there is abundant drainage of light colored bile containing small amounts of the bile pigments. Little change occurs in content or volume of the urine, and the blood urea remains persistently low.

It is not our purpose to go into the extensive literature on jaundice but a few outstanding facts pertinent to this discussion deserve mention. Rowntree, Snell, and Greene have made experimental investigations on obstructive jaundice in the most exhaustive detail. In the dog they did not observe suppression of urine and they found the blood nitrogen and its partition largely unchanged except for a terminal rise. uric acid did not appear. Bile pigments increased in value for 2 to 3 weeks then remained constant, due apparently to decreasing production; the initial increase was much more rapid when the gall bladder was removed at the time of the production of obstruction to the common bile duct. It was also found that ascites would appear when the animals were put on a protein diet and that it disappeared on resumption of a carbohydrate diet. It is not yet known definitely whether bile pigments or bile acids are the toxic factor in jaundice. It was the finding of King and Stewart that the injection of the pigment and not the salts of bile produced bradycardia and low blood pressure. The finding of bilirubin in the tissues does not necessarily mean of course that it is alone responsible for the parenchymatous damage observed. Haeseler, Rous, and Brown found that the elimination of bile pigment during jaundice was markedly increased in the dog by flood diuresis with intravenous saline solution; the effect on the bile salts was unknown. No such effect was obtained by diuresis from water by mouth, but these authors felt that accumulation of bile pigments might be diminished by such diuresis. The 'flood diuresis' was produced with saline solution introduced at such a rate as to be prohibitory in clinical use. They give a very thoughtful discussion of the significance of jaundiced epithelial cells in the urine sediment as evidence of renal injury. Wangensteen and his co-workers investigated the effect of repeated administration of ether and chloroform on output of phenol sulphonephthalein following experimental obstruction of the common bile duct in dogs. They found no evidence of impairment of kidney function nor did anuria develop, the urea nitrogen showed a terminal rise in only 2 of 16 dogs.

This raises the question of the interpretation of renal function tests in cases in which both kidney and liver damage is suspected. Hanner

and Whipple produced characteristic lesions of the liver by chloroform and phosphorus and in other cases produced obstructive jaundice in dogs. They then found in all cases an increase in phthalein excretion by the kidneys. They explained this by assuming that the 10 or 15 per cent of phthalein excreted through the bile by the healthy liver was shunted through the kidneys when liver function was grossly impaired. Their conclusion was that an abnormally high phthalein output in the presence of healthy kidneys should make one suspicious of serious impairment of liver function. For our own purposes, this adds to the value of the test. However the kidneys may be badly damaged in biliary infections with or without jaundice and without serious impairment of liver reserve, in our opinion, though our own clinical cases are not reported in such a way as to offer conclusive evidence in support of that opinion. Case 13 (aged 53 years) on the other hand with gross and microscopic evidence of hepatitis and phthalein excretion of 85 per cent in 1 hour after intravenous injection, probably is a case which fairly bears out the contention of Hanner and Whipple. In their paper they quoted Moller and Lumsgaard as reporting a delay and decrease in phenolsulphonephthalein excretion in patients with hepatic disease; these cases are spoken of by Chabrier and Ganne in the paper as having had evidence of renal insufficiency. The subject must be regarded as being still controversial, especially in view of the fact that Hanner and Whipple's work is based on animal experimentation.

Wakefield, Power, and Keith have recently reported a large series of determinations of inorganic sulphates of the blood by an original volumetric method as a criterion of early renal insufficiency in chronic nephritis. Their cases are carefully and fully presented and merit close inspection. They found the sulphates increasing before a fall in phenolsulphonephthalein excretion. The closest correlation existed between the behavior of the sulphates, the "urea clearance" test of Van Slyke and the specific gravity of the urine as determined by the concentration-diuresis test of Volhard and Fahr. It will be interesting to see whether this method of sulphate determination will give us warning of impending kidney insufficiency in gravely sick patients with diseases of the biliary tract.

We have depended on examination of the urine determination of blood non-protein nitrogen, phthalein excretion, and various modifications of the Volhard and Fahr concentration-diuresis test in our estimations of the anatomical and func-

tional state of the kidneys. It has not been possible to do them all or to repeat them at will in many of our patients. We have felt that more dependable results are obtained by injecting phthalein intravenously rather than intramuscularly since absorption rate must vary considerably from subcutaneous tissue fat and muscle into which the dye is variously deposited by different individuals. In clinical practice it is essential that voided specimens from women be uncontaminated every detail of the test indeed must be closely checked if one hopes to have valid records of progress. In the presence of jaundice, color matching with the standard is frequently impossible unless bile pigment be removed from the urine by one of the various methods. We find the ability to concentrate urine more satisfactory as a functional test and closely controlled research and experimental work by many workers has shown it to be of great value (10). We have not been interested in the ability of these patients to show diuresis since the cases that develop suppression of urine excrete urine of low specific gravity; we have tested only their ability to concentrate therefore. Here again carrying out of a formal concentration test involving the withdrawal of fluids for a period of 15 hours or so is usually out of the question from a therapeutic point of view with patients who are acutely ill. In such cases the phthalein excretion is more widely useful. Until recently we have performed concentration tests with the patient on bed rest and on general hospital diet with or without meat, previous to the test. At 6:00 p.m. to 6:00 a.m. as one specimen from 6:00 a.m. to 9:00 a.m. all urine is collected as a second specimen the amount and specific gravity (by hydrometer) of both specimens is then measured. Patients whose kidneys we regard as being entirely normal do not ordinarily have a specific gravity below 1.015 or above 1.020 for the second specimen. This has seemed to us an inadequate method since the specific gravity of the combined specimens from 6:00 a.m. to 9:00 a.m. tells us nothing of the specific gravity of any of them unless the total quantity be quite small (less than 100 cubic centimeters) which is not usually the case. We have more recently therefore had the patient attempt to void at 7:00 a.m., 8:00 a.m. and 9:00 a.m., and catheterized for the final specimen if unable to void. These specimens are saved as separate ones. In this way we obtain one or two specimens of only an ounce or two for our final specimens and if such are not concentrated we can feel assured that some functional renal impairment exists.

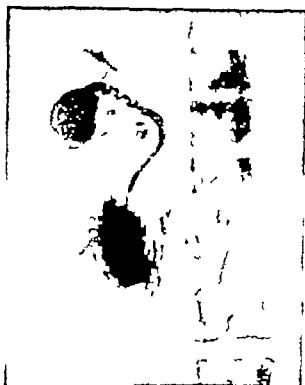


Fig. 1. (Case 7) January 2, 1931 injection through Pessar catheter in gall bladder. Preliminary cholecystostomy November 20, 1930. Note normal cystic duct small patent common duct. Subsequent cholecystectomy without exploration common duct, was done March 24, 1931.

Quantities of urine less than one ounce are accurately diluted with water to an amount the specific gravity of which can be measured by the hydrometer. We have not had sufficient experience with this method to have set up an arbitrary standard of normal but it is our impression that one of the specimens after 6:00 a.m. should go above a specific gravity of 1.020 on this regimen with normal kidneys. We are aware of the many factors such as humidity, temperature and emotional states which influence the output of water through the kidneys and we attempt to take them into account as fully as possible in interpreting the results of these tests.

We are presenting the following 13 case records of patients with disease of the biliary tract that were or had once been amenable to surgery. Cases 1 to 6 are those who developed suppression of urine with other signs of nephritis. Case 12 probably belongs in this group also though his urinary output was not recorded. Cases 1, 6, 7, 8, 9 and 10 are submitted as those in whom a graded operation was planned cholecystostomy with maintenance of drainage for several months by Pessar catheter being the preliminary steps. Cases 11, 12 and 13 are



Fig. (Case 8 May 9, 31, incision through Pessar's incision in gall bladder. Preliminary cholecystostomy September 18, 1930. Note complete obstruction common duct dilatation cystic, common and intrahepatic tree. Subsequent cholecystectomy and exploration common duct May 14, 1931.

patients in whom no further operation than cholecystostomy was contemplated.

CASE. Mrs. M. S. age 57 years, admitted to the hospital, November 25, 1928 complaining chiefly of abdominal pain, jaundice, vomiting. First gastro-intestinal symptoms appeared 5 years previously with attacks of severe pain in right upper quadrant, vomiting, deep jaundice, clay colored stools. Patient could not get back to normal diet for 6 months. Health has been fair since, with intermittent attacks, mild pain, acholic stools, and constant belching and fullness after meals. She has not suffered a loss of weight. Present attack was of 3 weeks duration, no urine was voided for 24 hours before entrance.

Examination revealed an obese, elderly woman in considerable pain, nauseated, fairly alert, skin and sclera slightly yellow, obvious dehydration, heart slightly enlarged to left, regular sounds distant, blood pressure 160/72, pendulous abdomen, right rectus abdominis marked tenderness and infiltration, right upper quadrant a tender mass size of grapefruit and dull to percussion is palpable, liver not felt, temperature, 98 degrees, pulse 70-80, respiration, 18, white blood cells, 50,000, vomitus contained bile.

Patient was given hypodermoclysis of 1,600 cubic centimeters of saline on night of admission, morphine, and gastric lavage. She did not thereafter have enough pain to require morphine. At 7:00 a.m. November 26, she voided $\frac{1}{4}$ ounce for the first time in 36 hours. Hypodermoclysis was resumed and 50 per cent glucose was given intravenously. She was catheterized 4 hours later and there was obtained $\frac{1}{4}$ ounce of dark yellow urine, acid, showing a plus albumin, no bile, numerous white blood

cells and red blood cells, occasional coarsely granular casts, and numerous bacteria. During the rest of the day she voided 84 cubic centimeters. Total output was 124 cubic centimeters for the 30 hours since admission with an intake of 3,700 cubic centimeters by hypodermoclysis, 600 cubic centimeters of blood, and 500 cubic centimeters of 50 per cent glucose intravenously. At this time white blood corpuscle count was 37,000 with 86 per cent polymorphonuclear red blood corpuscles, 500,000, hemoglobin 98 per cent, non-protein nitrogen, 53, ketone index 15, blood pressure, 142/80. During that night she voided total of 370 cubic centimeters with an intake of 2,100 cubic centimeters under the skin. The following day she again received 50 per cent glucose intravenously and 1,900 cubic centimeters hypodermoclysis and the urinary output suddenly rose to 1,730 cubic centimeters in 24 hours. Urinalysis on November 26, showed 1 plus albumin acid, specific gravity, 1.005, numerous white blood corpuscles and red blood corpuscles, a moderate number of coarsely granular casts, acetone, negative. White blood corpuscle count had dropped to 3,000, temperature became normal, with pulse averaging 80. November 28, fluids in small amounts were started by mouth and the urinary output continued to exceed the fluid intake until December 4, there being considerable diuresis at night and there having been no demonstrable edema at any time. November 28 the non-protein nitrogen was 63, blood pressure, 140/70. December 1 non-protein nitrogen was 45; blood pressure, 110/60; and electrocardiogram showed normal curves. December 3, non-protein nitrogen was 44, blood pressure, 100/60. December 4 catheter urine specimen showed reaction, acid, specific gravity 1.005, trace albumin, a few white blood corpuscles, and bacteria. December 5, white blood corpuscles numbered 9,800. December 6, ketone index was 10. There was no nausea after December 5 but a persistent sensation of abdominal fullness and belching was noted.

Operation was done December 17. Nitrous oxide gas plus novocain infiltration and block anesthesia was used. An enormous gall bladder filled with thick black bile and stones was aspirated, sutured to peritoneum, and a large soft rubber tube sutured into the gall bladder for drainage; no exploration was attempted.

The postoperative course was uneventful except for considerable lagging of urinary output behind the fluid intake during the first 3 days. Patient was discharged December 29, 1928, with a small amount of seropurulent drainage around the tube. Bile drainage was prompt following operation and decreased in amount after the first few days, not exceeding 500 cubic centimeters each 24 hours during the final week in the hospital. During the first 3 weeks after discharge patient passed twice a stool through the tube which came out 6 weeks after operation and was not replaced. Stools were of normal color at all times. There was a small but constant amount of drainage from the fistula, the belching and sensation of fullness disappeared and there were no pain, chills, or jaundice.

Patient was readmitted to the hospital June 18, 1929, having been for 1 week on a 1,000 calorie diet with thyroid, grain 1/30, daily. Reduction regimen continued for 1 week after entrance. Catheter urine showed reaction, acid, specific gravity, 1.017; slight trace of albumin, occasional white blood corpuscles, hemoglobin, normal temperature, pulse, and respiration, normal blood pressure, 160/80.

Operation was done June 25, 1929. Nitrous oxide and novocain infiltration and block anesthesia were used. The abdomen was opened just lateral to the old scar; the gall bladder was moderately thickened. It was aspirated



Fig. 3. Case 10. February 2, 1931, injection through Pezzer catheter in gall bladder. Preliminary cholecystostomy July 29, 1930. Common duct apparently normal, emptying promptly. Subsequent cholecystectomy not yet done (see text).



Fig. 4. Case 14. October 31, 1930, injection through T tube in common duct. Excision stricture and choledochostomy December 10, 1930. Note persistent dilatation of common duct and intrahepatic radicals. T tube removed December 4, 1930.

and packed the ducts appeared normal in size and thickness. Cholecystectomy was performed with drainage to stump of cystic duct.

The postoperative course was entirely uneventful. The urine output was good at all times. Patient was discharged July 11, 1929. On April 3, 1932, she was re-examined. Digestion has remained excellent, no pain or jaundice, regained weight to 203 pounds during past winter but has recently developed toxic adenoma thyroid and diabetes mellitus and weight has fallen to 165 in the past 4 months.

Case 2. Mrs. M. B., aged 58 years, was admitted April 5, 1929. The chief complaint was jaundice with continuous vomiting. Onset of jaundice 1 month ago with mild pain in both upper abdominal quadrants, nausea, and vomiting with increasing severity incontinence of urine and feces, stuporous past 48 hours. Past history was not obtained.

Examination revealed an obese elderly woman, deeply jaundiced, stuporous, obviously dehydrated, marked fetor oris, teeth poor; lungs entirely clear; heart rapid, regular, size uncertain; sounds rather distant, no murmurs; blood pressure, 105/52. The abdomen had no scars, both upper quadrants and epigastrium were tender and spastic; the liver was not palpable, no masses were felt; the pelvis was not examined; no edema of extremities; temperature, 99.2 degrees; pulse 115; respiration, 24. The catheter urine was dark brown, acid, specific gravity 1.009, 3 plus albumin, bile, positive; moderate number red blood cells, a few white blood cells and granular casts.

Immediate blood transfusion was given and intake maintained by hypodermoclysis of saline and 10 per cent glucose intravenously. Small nasal tube was introduced into

the stomach and left there 150 cubic centimeters of orange juice being inserted every 3 hours. Intake from entrance for 20 hours: nasal tube 750 cubic centimeters; hypodermoclysis, 2,800 cubic centimeters; intravenous, 1,000 cubic centimeters; total, 4,550 cubic centimeters. Output: she vomited small amounts twice; urine was voided involuntarily twice in very small amounts; per catheter 180 cubic centimeters; total? April 6, white blood corpuscles were 13,000; red blood corpuscles, 5,250,000; hemoglobin, 100; non-protein nitrogen, 53; icterus index, 130; urine many red blood cells and 1 plus albumin; pulse 85; blood pressure 118/65. Patient was still stuporous. Twenty-four hour intake: mouth, 2,300 cubic centimeters; hypodermoclysis, 3,600 cubic centimeters; intravenous, 100 cubic centimeters (50 per cent glucose); total 6,000 cubic centimeters. Output: stomach syphonage 1,350 cubic centimeters; urine 610 cubic centimeters; per catheter, total 1,960 cubic centimeters. April 7, patient failed rapidly; temperature stayed normal and pulse was under 100 until 2 hours before death at 6:50 p.m. Marked edema developed around eyes and moist bronchial rales appeared at 11:00 a.m.; blood pressure 168/90 at this time. No precordial friction rub was heard. Intake from 7:00 a.m. until 6:50 p.m.: mouth, 340 cubic centimeters; hypodermoclysis, 1,000 cubic centimeters; 50 per cent glucose intravenously 50 cubic centimeters; total, 2,100 cubic centimeters. Output: syphonage 1,425 cubic centimeters; urine 250 cubic centimeters; per catheter, total 1,675 cubic centimeters. Autopsy was performed immediately following death. Moderately increasing bile stained fluid was found in pericardium and peritoneum; there were hemorrhages into the wall of the small intestine and cecum amounting almost to gangrene; the



Fig 5. Case 5. June 10, 932 injection through T tube in common duct. Cholecystectomy and cholecystectomy May 23, 932. Note dilatation common duct and intrahepatic radicals, with prompt emptying though patient in Trendelenburg position.

appendix was densely fixed in old adhesions and contained one fecalith the liver was rather small with dilated ducts gall bladder hydropic and adherent to stomach f ramen of window obliterated no stone in common duct a hard mass size of lemon in head of pancreas, right kidney weighed 75 grams, left a little less, surfaces smooth, capsules stripped easily cut surfaces showed well defined cortex and medulla, petechial hemorrhages into renal pelvis heart negative except for deep jaundice which all organs showed. All parenchymatous organs, stomach, duodenum, and pancreas were saved for microscopic examination but were misplaced and no report of them is available.

Case 3. Mrs. H. F. age 71 years, admitted December 14, 1931. Her chief complaint was jaundice and indigestion. Eight years ago she had had attacks of nausea, vomiting without pain or jaundice over a period of 2 months. Five years ago she had an attack of severe pain in the upper abdomen and chest radiating to back lasting 3 days and associated with much nausea, nocturia once or twice nightly for past year increasing to 4 or 5 times in past 6 months. Six months ago she had noted onset of weakness, but loss of less than 5 pounds, clay colored stools for 2 months. edema of legs to groins for 2 weeks, nausea and belching but no vomiting or pain some palpitation past 2 weeks no orthopnea or dyspnea. She was confined to bed for past weeks without improvement. Very small doses of digitals were given for week before admission. The onset of jaundice has been so gradual that it cannot be definitely dated.

Examination revealed a stout elderly woman, alert, not in pain. The skin was a peculiar bronze, the sclera yellow; the heart was not enlarged, the apex impulse was some-

what diffuse, the sounds were clear regular of good quality with no murmurs, an occasional extrastole. Blood pressure was 140/75 the lungs were negative. The abdomen showed no scars the wall was relaxed the right lobe of the liver was felt 3 finger breadths below right costal margin edge rounded, perhaps irregular, and slightly tender. The gall bladder was palpable, tender. No free fluid demonstrable. The back showed slightly pitting edema over lumbar and sacral regions. The pelvis and rectum were not examined. Pitting edema noted on both legs to knees. No varicos were noted in legs or abdominal wall. Temperature was 96.2 degree; pulse, 82 respiration, 22. Catheter specimen of urine was acid, specific gravity 1.009, bile, positive; very occasional red blood corpuscle and cocci hemoglobin 77 per cent, red blood cells 4,800,000 white blood corpuscles, 7,600, differential (Schilling)—eosin, 3 sticks, 28 segmented, 42 lymphocytes, 22, large mononuclears, 5 leucocytes index, 60 van den Bergh, positive, direct reaction stool, negative for bile and for occult blood. Intravenous iodohexon gave no gall-bladder shadow but there were characteristic shadows of stones in gall-bladder area. Forty-two per cent of the dye was retained in the blood 30 minutes after injection. Electrocardiogram showed T waves broad and flat in all leads and left axis deviation.

Impression. Obstructive jaundice due to (silent) stone in common duct or less likely pressure on common duct from carcinoma of gall bladder. The edema was thought to be due to myocardial failure with incomplete digitalis effect.

Patient was put on limited fluid intake with salt-free diet high in carbohydrate on December 1 the edema of the legs and back had almost completely disappeared and the liver was barely palpable. During this 24 hour period, however she voided only 40 cubic centimeters. Intake of digitals, 1 cubic centimeter every 4 hours, was started as a diuretic although the pulse was 80. December 17 patient was weak, drowsy complaining of visual disturbance. Fifty per cent glucose was given intravenously with insulin and blood transfusion. Total intake was 1,500 cubic centimeters. Output urine was 170 cubic centimeters, and there was again considerable edema of the back. December 18, non-protein nitrogen was 47 leucocytes index, 75 catheter urine, acid, specific gravity 1.012 2 plus albumin, bile positive, numerous white blood corpuscles, and bacteria. I take 2, 00 cubic centimeters. Output 410 cubic centimeters after cubic centimeter of salyrgan intravenously. December 19, 3 cubic centimeters salyrgan was given intravenously to 30 per cent glucose with insulin and repeated daily thereafter. Catheter urine showed reaction, acid, specific gravity 1.005 3 plus albumin bile positive a few red blood corpuscles, and a moderate number of white blood corpuscles. Intake was 1,600 cubic centimeters. Output was 480 cubic centimeters. December 20, patient was quite drowsy considerably weaker edema legs and back was increasing, but no ascites or pulmonary edema were noted. Digitals was discontinued since the pulse remained about 70. As bedwetting catheter was inserted in order to keep track of the urinary output as patient was beginning to void involuntarily. Stools were light brown for the first time and were faintly positive for bile which was present thereafter until death. Leucocytes index was 110. Carbon dioxide combining power was 38.5 volume per cent; blood chlorides 310 milligrams. December 21 intake was 2,170 cubic centimeters, output 780 cubic centimeters. The urine was unchanged. Temperature, pulse, and respiration remained normal, blood pressure 110-60. December 22 patient was quite stuporous. Intake was 1,380 cubic centimeters, output was 560 cubic centimeters. The urine was acid,

specific gravity 1.005, 3 plus albumin, numerous red blood corpuscles, white blood corpuscles, and bacteria. December 23 patient expired.

Permission for autopsy limited to abdomen was obtained. The findings are to be reported in detail in another paper primary adenocarcinoma of the liver cells (malignant hepatoma) with small organoid metastases to the lungs, peritoneal fibrosis, chronic cholecystitis with cholelithiasis, marked dilatation of common duct with small fresh ulceration of mucosa (stone not found in duct or in intestine) small retention cysts in pancreas, slight necrosis of peri-pancreatic fat, chronic perisplenitis, cloudy swelling of the kidneys with deposit of albuminous material in the glomerular capsules and in the tubules marked jaundice of viscera. The heart was examined through an incision in the diaphragm. It was not grossly enlarged and the muscle was soft. There was a moderate amount of bile-stained fluid in both pleural cavities and a small amount in the peritoneal cavity.

CASE 4. Mr L. P. aged 53 years was admitted to the hospital April 8, 1932. Patient had been under observation as an ambulatory case until the night before entrance. The referring physician had studied him exhaustively a month previously with complete gastro-intestinal and gall bladder X-rays, blood chemistry, electrocardiograms, etc. and a final diagnosis of cholecystitis with cholelithiasis had been made. The urine had then been normal and phenolsulphonphthalein excretion was 75 per cent in 3 hours after intravenous injection. There was a history of epigastric pain, abdominal fullness, and belching after meals, in spells, for about 10 years. Constant jaundice varying in degree had been present for 2 months before admission, clay colored stools for 1 month swelling of abdomen (ascites) for 10 days, oedema of ankles for 4 days. On admission there was noted a deep jaundice of the skin and sclera. Patient was somewhat drowsy, lips and nails were cyanotic, audible moist rales were noted throughout bronchial tree. Percussion note was dull in lower axilla and posteriorly. The apex impulse was diffuse in fourth intercostal space 5 centimeters to left of sternum, sounds faint and regular, no murmurs. The abdomen was distended, shifting dullness present in both flanks. There was slight tenderness in the right upper quadrant and epigastrium, no masses or viscera were palpable. Pitting oedema noted in lower anterior abdominal wall and back. The genitalia and rectum were negative. Pitting oedema noted in feet and ankles. Temperature was 100 degrees, pulse, 128, respiration, 24, blood pressure, 115/60. Catheter urine showed acid reaction, 3 plus albumin, bile positive, a few hyaline and granular casts, moderate number red blood cells, a few white blood cells and bacteria. Hemoglobin 65 per cent, red blood count 3,000,000, white blood count 8,000 differential (Schilling) basophils, 1; Y oung, 45 stab, 30 segment, 12 lymphocytes, 10, icterus index, 60.

In the first 36 hours, April 8 to 9, only 160 cubic centimeters of urine was passed with fluid intake of 2,000 cubic centimeters of 5 per cent glucose intravenously and a negligible amount by mouth and proctoclysis. When we first saw the patient on the morning of April 9 he was quite stuporous, physical findings had not changed since admission, blood pressure 118/60, pulse 124, respiration 24, and it was our impression that he had in addition to obstructive jaundice a nephritis which was responsible for his oedema rather than circulatory failure. Non-protein nitrogen was 68, uric acid 4.4. An attempt was made to start diuretics with salyrgan and 50 per cent glucose intravenously which were repeated 12 hours later. 450 cubic centimeters of blood was given as transfusion and oxygen started continuously by nasal catheter. Only 210 cubic centimeters were obtained before death which occurred on

the morning of April 9. Until shortly before death pulse remained around 120, respiration 24, temperature slightly subnormal. Permission for autopsy was refused.

CASE 5. Miss M. B. aged 61 years, admitted to hospital April 4, 1928. Her chief complaint was increasing jaundice and abdominal pain. The first attack of severe pain in the right upper quadrant of the abdomen occurred 14 years ago with bloating and fullness after meals. She had had several similar attacks of colic during the next 4 years none for the past 10 years though indigestion continued. Two weeks ago she had a sharp attack of pain followed the next day by jaundice which has steadily increased with clay colored stools and considerable vomiting. No vomiting had been noted for past few days.

Examination revealed an obese elderly woman deeply jaundiced, not in pain, quite nervous, belching frequently. The heart was slightly enlarged to left. The abdomen was quite tender under the right costal margin otherwise negative. The temperature varied from normal to 99.9 degrees, pulse varied from 68 to 110 with the temperature. April 5 hemoglobin was 85 per cent, white blood cells 6,000 clotting time 5 minutes, icterus index, 150 van den Bergh, immediate direct reaction, urine acid specific gravity 1.015, faint trace albumin, bile positive numerous leucocytes, a few hyaline and granular casts.

She was given intravenous glucose on admission. April 6 blood transfusion, calcium chloride was given intravenously on three successive days. She was put on a high carbohydrate diet. There was inconstant nausea, no vomiting, stools of normal color after April 6. Temperature came back to normal on April 8 and went up to 100 on April 10 and to 101 degrees on April 16. It was thereafter normal. April 13 icterus by mouth gave an uncertain hazy shadow in gall-bladder region. Icterus index 150 on admission 180 on April 7, 100 on April 10, and 60 on April 14. Non-protein nitrogen was 42 on April 7, April 16 white blood cells were 6,000 clotting time 4 1/2 minutes.

Operation was done April 21. Ether and novocain infiltration and block anaesthesia were used. The gall bladder was cystic, the common duct thickened, enlarged, and buried in dense adhesions. One mulberry pigment stone was found in the gall bladder. The common duct was opened, and careful exploration revealed no stone or obstruction. There was free passage into duodenum. A catheter was sutured into the hepatic duct. A drainage tube was sutured into the gall bladder in view of patient's age and rather poor condition. Penrose drain was inserted into the common duct. Pulse was 94 at conclusion of operation.

Postoperative course. Temperature was 103 degrees night of operation and 101 degrees the following morning. April 23, pulse suddenly went from 100 to 160. Heart action was regular. Blood pressure was 110/80, the pre-operative level, and there was a suggestion of pulsus alternans. Respiration was 24. Patient was digitalized on advice of consultant, with massive doses, and was then maintained on digitalis thereafter. Pulse returned to 90 that night and was usually between 80 and 90 thereafter. Bile drainage was immediate, averaging 600 cubic centimeters in 24 hours for 1 week. Stools were of normal color until eighth day after operation. April 29 they were continuously clay colored thereafter until death. A moderate amount of bile-stained drainage continued on the dressings but no digestion of skin occurred. Following operation water intake was maintained by mouth, 2,000 to 2,500 cubic centimeters daily. The urine on day after operation showed faint trace of albumin, specific gravity 1.024, and was normal microscopically. Urinary output declined steadily from 800 cubic centimeters in 24 hours to less than 100 cubic centimeters daily. This was not noticed

until April 26 when patient began to complain of urgency which responded to symptomatic treatment. April 26 specific gravity was 1.014, faint trace albumin, bile positive, numerous white blood cells, a few hyaline and granular casts. Fluid intake thereafter was peaked beyond 3,000 cubic centimeters daily and blood transfusion was given. The urine output fell to between 350 and 450 cubic centimeters daily however until death. April 25 temperature rose to 32 degrees, then gradually fell to subnormal where it remained until the day of death. April 30 non-protein nitrogen was 60 urine showed heavy trace of albumin, bile positive, a few red blood cells and white blood cells, and small bacilli. No further laboratory examinations are reported until death which occurred on May 6, 1938. Patient was restless and disoriented during the last week. Permission for autopsy refused.

CASE 6. Mrs. C. K., aged 63 years, was admitted to the hospital October 20, 1930. She had had an attack of nausea and vomiting one year ago with burning sensation in epigastrium lasting 3 days. She had suffered from fullness and belching after eating since then. Forty-eight hours ago burning pain in epigastrium and right upper quadrant recurred and vomiting of bile-stained fluid started. Pain was continuous, shifting 12 hours ago to right lower quadrant vomiting was intermittent. Stools were normal and daily during present illness. There were no cardiorespiratory or genito-urinary symptoms no chills or jaundice. She was given morphine by referring physician before she sent 75 miles to hospital with diagnosis of acute appendicitis.

Examination revealed an obese, elderly woman mentally alert, but very tired in moderate pain skin and sclera normal, head and neck negative except for dry tongue heart enlarged somewhat to left, sounds of good quality. A snapping, occasional extrasystole was noted. The lungs were slightly emphysematous. The right rectus muscle was in moderate spasm. There was marked respiratory inhibition. The liver edge was palpable 3 to 4 finger breadths below the rib margin on the right. Continuous with it there was a tender tense mass the size of a lemon extending to the level, and to the right of the umbilicus, and moving with respiration. Pelvic examination revealed no tenderness or induration on either side. Temperature was 93.4 degrees pulse, 86 and respiration, 30 blood pressure 140/85 white blood cells, 34,000. Catheter urine, showed acid reaction, 3 plus albumin, many hyaline and finely granular casts, occasional white blood cells, no organisms, non protein nitrogen 37. A flat film of the abdomen showed clearly a gall-bladder shadow at site of the tender mass. Impression empyema of gall bladder. Patient was put on penicillin treatment with nothing by mouth 3,000 cubic centimeters saline solution as hypodermoclysis, 1,000 cubic centimeters 10 per cent glucose intravenously in the 16 hours until the morning following admission. During this time she voided 150 cubic centimeters of urine. October 30, white blood cells were 25,300 temperature, 99.8 degrees pulse, 96 respiration, 22. Patient felt greatly rested.

Operation was done October 30. Nembutal, grains 3, was given intravenously pituitous oride and local infiltration and block anesthesia being used. Through a short, high right rectus incision the abdomen was opened. The peritoneal fluid was found to be bile-stained and greatly increased in amount. The gall bladder was freed from the omentum. It was the size of a small coconut, greatly thickened, and dark blue in color. It was lifted into incision and attached to fascia with Allis clamps and aspirated of thick blue green bile and many tiny stones. A Pezzer catheter was introduced, one plain gauze pack and two small iodoform packs were left in the wound

around the gall bladder to create adhesions. Closure to packs and tube, the clamps being left in place. A note was made on the operative chart that patient was to wear the Pezzer catheter for 6 months and then have a cholecystectomy. At end of operation pulse was 120, respiration, 25, blood pressure, 134/70. Blood transfusion was given immediately and penicillin treatment resumed for 24 hours. During this period with a total intake of 3,300 cubic centimeters the output of urine was 785 cubic centimeters. Temperature was 101.3 degrees, pulse, 100; and respiration, 25, the night of operation gradually returned to normal in the next 3 days. She was put on soft diet on the third day. There was immediate bile drainage, not exceeding 100 cubic centimeters per 24 hours. Stools were normal in color at all times. Gauze packs were removed at intervals until the twelfth day. Patient was to be allowed up on November 12, but that morning she developed a left-sided bronchial pneumonia of which she died November 21. Permission for autopsy refused.

CASE 7. Miss L. M., aged 37 years, was admitted to hospital November 13, 1930. Since appendectomy for ruptured appendix 6 years ago she has had spells of minor upper abdominal discomfort especially after eating raw fruit. Four weeks ago there was a sudden onset severe pain in the right upper quadrant and epigastrium, the pain radiating around the rib margin to the right axilla, there were considerable vomiting, fever, and onset of jaundice. Morphine was required to relieve pain. She vomited 3 to 5 times daily for a week, once daily since then. Jaundice gradually subsided, she had had no chills; uncertain as to acholic stools. The past history was negative except for scarlet fever and diphtheria when a child. Examination revealed a short, rather obese woman, not in pain, skin slightly yellow, sclera clear head, neck, heart, and lungs negative. Blood pressure 135/85. There was an old low right rectus scar, healed by secondary intention no distention or spasm, moderate tenderness in epigastrium and right upper quadrant slight inhibition, no masses or viscera palpable. Pelvis and rectum not examined. Temperature was 93 degrees, pulse, 88 and respiration, 18. Catheter urine showed acid reaction, specific gravity 1.014, faint trace of albumin, bile negative, sediment negative haemoglobin 83 per cent; white blood cells 6,000 differential (Schilling) normal keton index 5.1 Impression chronic cholecystitis with subsiding acute exacerbation, question of stone in common duct. November 14, phenolphthalein 540 cubic centimeters, 45 per cent in 8 hours (intramuscular). Because of history of definite changes in color of stool during first week of attack it was felt that her common duct would have to be explored. Because of her thick, peculiarly deep thorax and abdomen this promised to be very difficult. It was felt that her phenolphthalein cholecystectomy should improve before undertaking so radical a procedure.

November 15, urine concentration test 6 p.m. to 6 a.m. 7 cubic centimeters, specific gravity 1.0. 6 a.m. to 9 a.m. 17 cubic centimeters, specific gravity 1.008. Phenolphthalein 530 cubic centimeters, 37.5 per cent in 8 hours (intramuscular). November 16, phenolphthalein 630 cubic centimeters, 37.5 per cent in 8 hours (intramuscular). With this definite evidence that kidney function was far from normal we informed patient that she could either wait until kidney function improved with the risk of further attacks of colic in the meanwhile or have cholecystectomy performed at once with subsequent cholecystectomy and exploration of common duct. She preferred the latter course.

Operation was done November 20. Phenadon, grains 15, was given preliminary to operation. Nitrous oxide plus local infiltration and block anesthesia were used.

Through a lateral right rectus incision the fundus of the gall bladder was brought into the wound and anchored with Allis clamps and a Pezzar catheter was inserted into it. Clamps were left in place for 48 hours.

Postoperative course was uneventful for 9 days. The urinary output good. Immediate bile drainage was from 100 to 300 cubic centimeters per 24 hours when it exceeded 200 cubic centimeters, it was injected into the rectum as retention enema, patient in chair on seventh day. On ninth day developed thrombophlebitis on left saphenous vein. This improved on the usual treatment. December 11, 1932, she was discharged. The incision was healed to the catheter. January 1, 1933, she was readmitted to have Pezzar changed. She has had two attacks of colic similar to those before operation but they were much less severe and without jaundice. The stools have remained normal in color. Temperature, pulse and respiration were normal. Blood pressure 120/80. Urine concentration test showed 6 p.m. to 6 a.m. 2 cubic centimeters specific gravity 1.002 6 a.m. to 9 a.m. 2 cubic centimeters specific gravity 1.014 Phenolsulphonphthalein output was 155 cubic centimeters, 47.5 per cent in 2 hours (intramuscular). Voided urine showed reaction alkaline, 1 plus albumin moderate number white blood cells, a few red blood cells. Lipidol injection into catheter showed no obstruction in the common duct and prompt emptying into duodenum. February 16 she was readmitted to have the Pezzar changed. She had had entire comfort until a week ago when the catheter began to slip out of the gall bladder and with partial blocking of fistula the gall bladder became tender red and there was a slight purulent discharge. Temperature pulse, and respiration were normal blood pressure was 120/80. The urine concentration test showed 6 p.m. to 6 a.m. 2 cubic centimeters, specific gravity 1.017 6 a.m. to 9 a.m. 2 cubic centimeters, specific gravity 1.013 Phenolsulphonphthalein 185 cubic centimeters, 42.5 per cent in 2 hours (intramuscular). Lipidol injection into catheter showed common duct patent and emptying promptly. March 18, 1933, she was readmitted for cholecystectomy having felt well in all respects except for occasional soreness about the tube. Lipidol injection gave results as before with no dilatation of hepatic or common ducts. March 19, concentration test showed 6 p.m. to 6 a.m., 525 cubic centimeters specific gravity 1.010 6 a.m. to 9 a.m., 60 cubic centimeters specific gravity 1.011 Phenolsulphonphthalein 720 cubic centimeters, 53 per cent in 2 hours (intramuscular). March 23, concentration test 6 p.m. to 6 a.m., 2 cubic centimeters specific gravity 1.000 6 a.m. to 9 a.m., 2 cubic centimeters specific gravity 1.002.

Operation was done March 24. Nitrous oxide gas and anesthesia was used with ethylene novocain block of abdominal wall. Through a right rectus incision between the midline and fistula the common and hepatic ducts were found to be normal in size and consistency. No stones were felt and the ducts were not opened. Gall bladder wall was 1 inch thick on the peritoneal aspect. It was removed and a small gauze pack partially surrounded by rubber was placed against the liver bed and brought out old fistula.

After operation the urine output was satisfactory at all times, approximating the intake after the first 24 hours. The course was uneventful except for considerable purulent drainage from the sinus for several days after removal of packs and drains. No bile drainage was used. April 13 patient was allowed up. She elected to stay in the hospital until the sinus had completely granulated. April 26, 1933, she was discharged. March 30, 1933, she felt excellent was eating everything with good digestion until past December when she weighed 153 has since developed symptoms of thyrotoxicosis and has lost 10 pounds.

Pulse was 116 blood pressure 155/95. Patient refused to remain for complete examination but it is our impression that she has not only a toxic goiter but definite renal damage in view of high diastolic pressure.

CASE 8 Mrs. D. M. aged 63 years, was admitted to hospital August 31, 1930. She had been entirely well until 1 month ago at which time there was an onset of severe pain in the right upper quadrant, radiating to back, and she became jaundiced had a sensation of fullness, she belched after meals and had pain which continued intermittently. She vomited several times with attack 3 days ago. The stools were frequently clay colored. Her past history was uneventful except for malaria 4 years ago. Her average weight was 120 pounds.

Examination revealed a moderately obese elderly woman in slight pain with slight jaundice of skin and sclera heart and lungs negative abdomen flabby fat positive inhibition moderate tenderness in right upper quadrant and epigastrium no masses or viscera were palpable extremities were negative weight 130 pounds. Temperature was 99.4 degrees pulse 88 and respiration, 22. September 3 red blood cells were 4,370,000 white blood cells, 9,400 hemoglobin 70 per cent differential normal icterus index, 12.1 non protein nitrogen, 30.9. September 3 temperature returned to normal and a glucose tolerance curve was normal no spilling of sugar. Urine concentration test was performed but the specimens were mislaid and no report was available. September 5 icterus index 10 catheter urine acid faint trace albumin bile positive a few red blood cells and white blood cells phenolsulphonphthalein 400 cubic centimeters, 75 per cent in 1 hour (intravenous). September 8 non protein nitrogen 32.4 icterus index 10.3 Patient's appetite was improving though she was still occasionally nauseated and her general strength was somewhat better. She no longer complained of intense weakness and prostration. She was started on thyroxin, grain 1/80, daily. September 16 calcium chloride 5 cubic centimeters of 10 per cent solution was given intravenously and repeated on the next 2 days.

Operation was done September 18. Morphine-atropine preparation nitrous oxide plus novocain infiltration and block anesthesia. Through a short, high, right rectus incision the gall bladder was exposed and found to be thick, small rather red and completely behind the liver. It was fixed to the upper angle of the wound with Allis clamps and aspirated. A Pezzar catheter was inserted into the gall bladder which was then fastened with Allis clamps to the fascia. Iodoform gauze was packed around the gall bladder and closure was made in layers around the pack and tube, clamps were left in place. Patient was returned to bed with a pulse of 94. After operation there was immediate bile drainage, highest temperature was 100 degrees the first night after operation. The urine output was satisfactory. On September 23 the clamps were removed. On September 26, patient was up in chair and the gauze pack was removed. On October 3 patient was discharged. The incision had healed except for a granulating area immediately around the Pezzar catheter. Bile drainage averaged only 2 to 3 ounces daily.

On October 15 weight was 154 pounds. Two stones passed through the tube. February 11, 1931, three stones were passed. March 15 stools had been normal in color since operation. The Pezzar was changed and Lipidol was injected for visualization of the biliary tree. Patient has recently had mild influenza. On May 18, patient was readmitted to hospital weight was 140 pounds, she having lost 10 pounds since influenza attack. Urine concentration test showed 6 p.m. to 6 a.m., 420 cubic centimeters, specific gravity 1.005 6 a.m. to 9 a.m., 180 cubic centimeters specific gravity 1.012 Phenolsulphonphthalein 390

cubic centimeters, 55 per cent in 2 hours (intramuscular); catheter urine was negative. smear of bile showed no pus, numerous gram-negative bacilli, and gram-positive cocci. Lipiodol injection through Pessar showed obstruction of the common duct and outlined the biliary tree exceptionally well.

Operation was done May 14. Phenobarbital grains 15, preparation Nitrous oxide gas and ethylene were used for anesthesia. Through an incision 2 centimeters to right of the midline everything was found to be adherent to the gall bladder at its junction with the abdominal wall. The ducts were considerably thickened and greatly dilated. Three small pigment stones were removed from the pancreatic portion of the common duct, a probe then entered the duodenum easily. A T tube was sutured into the hepatic and common ducts and a greatly thickened gall bladder was removed. A Penrose drain was inserted suture line, brought out with the T-tube through the previous biliary fistula.

After operation, the highest temperature was 100 degrees on the first day. It returned to normal on fourth day. Urine output was good. There was immediate bile drainage of 400 cubic centimeters daily for two days after which it decreased to about 50 cubic centimeters per 24 hours. The stools were 1 normal color except one passed on the eighth day; patient was quite weak and anesthetic for 4 days and was started on thyroxin grain 1/50, daily. Patient was slow in regaining strength, p on fourteenth day. On June 3, 1931, she was discharged, both day. A moderate infection of the drainage tract subsided on irritations.

July 7, 1931, the stools continued normal in color. We had been clamping off T-tube 1 past few weeks without symptoms. The T tube was removed October 30, 1931. No symptoms whatever were noted. July 1, 1932, weight

68 pounds. Patient eats everything. She has no gastrointestinal symptoms, no pain, bowels move daily; her general health and strength are excellent.

Case 9. Mrs. A. C. aged 62 years, admitted to hospital June 2, 1930. For 5 months she had attacks of paroxysmal pain in the right upper quadrant and epigastrium, with vomiting. She was jaundiced during most of the attack. Her last attack was 3 days before entrance to hospital, with chills and a temperature of 104 degrees. The pain subsided but there was persistent burning sensation in the region of the gall bladder. Her past history revealed that she had had an operation for cysts of the ovaries in 1903 following which the wound burst open and drained for 8 months. The wound reopened and following this she developed an incisional hernia. Operation for ruptured appendix was done in 1913.

Examination revealed a moderate degree of jaundice, heart and lungs negative. The abdominal wall was firm with two old healed incision scars and a small incisional hernia, the right rectus was spastic, there were marked induration and tenderness in the right upper quadrant. Temperature, pulse, and respiration were normal. Urinalysis revealed reaction, acid, specific gravity 1.000, occasional white blood cell. She was put on a high carbohydrate intake and fluids were forced. July 1, ketones index was 6.8. July 5, cholecystostomy was performed under nitrous oxide gas plus novocain infiltration and block anesthesia, after 15 grains of phenobarbital was given by mouth. Through a very short incision a large catheter was sutured into the gall bladder.

The postoperative course was entirely smooth. The catheter came out of gall bladder on the first day after operation and was replaced by a Pessar (mouthroom) catheter. July 10, patient was up in a chair. July 13, she was discharged. July 30, tube came out followed by a small

facted stone. The tube was replaced and continuous drainage instituted. September 26, patient was feeling excellent eating everything; weighed 120 pounds. October 30, patient reported passing considerable bile at all times through tube, but much more since an attack of headache and a fever of 103 degrees a week previously. Stools are always clay colored, and there was occasional diarrhea. Sharp epigastric pain was present at times for past few weeks. The appetite was fairly good, she had no chills; weight was 120 pounds. November 2, non-protein nitrogen was 30, ketones index, 5, phenolsulphonphthalein 245 cubic centimeters, 60 per cent in 2 hours (intramuscular). November 15, patient was readmitted to hospital. Blood pressure was 150/78. The liver was not palpable. A Pessar catheter was placed in the fistula. The stools were usually acholic. She had been fed bile salts continuously since previous discharge. She started on thyroxin, grain 1/50, daily. Catheter urine showed reaction, acid, specific gravity 1.015, microscopically and chemically negative.

Operation was done November 15. Phenazone, grains 15, preparation was carried out. Nitrous oxide anesthesia was used. Through an incision high in the right rectus and close to midline, the gall bladder appeared little changed. No stones were found in the gall bladder or cystic duct. The common and hepatic ducts enormously dilated, with walls gray and thick, the common duct contained multiple pigment stones in its entire pancreatic portion. The stones were removed and the instruments readily passed into the duodenum. A large catheter was sutured into the hepatic duct, a Penrose to suture line in common duct the wound was closed. Pulse was 78 at end of operation. The highest temperature after operation 101 degrees on first night normal after fourth day. Urinary output was good at all times. Bile drainage was immediate and averaged about 300 cubic centimeters for 24 hours, until the catheter came out of the hepatic duct on the eighth day after operation. Drainage through the Pessar catheter in the gall bladder was thereafter only about 75 cubic centimeters per 24 hours. December 4, up in chair. December 6, discharged with incision completely healed. There was no bile drainage around the Pessar catheter. The Pessar catheter was removed in March, 1932, after lipiodol injection had shown the common duct to be patent and emptying promptly into the duodenum. The fistula healed in about 10 days. May 19, 1932, patient weighed 125 pounds and excellent in every way. June 23, 1932, weight 125, digestion excellent, bowels moved daily without cathartic, eats everything; blood pressure 145/75; considers herself 100 per cent normal.

Case 10. Mrs. O. D. aged 40 years, was admitted to hospital July 26, 1930. For past 3 1/2 years she had had sensation of distention of abdomen and belching after meals, particularly after eating fat. Occasional stabbing pain in right upper quadrant during this time. She had had intermittent pain during past month no jaundice, stools of normal color.

Examination revealed the following: heart size cannot be made out, sounds regular, only fair quality; blood pressure 144/78, lungs negative, abdomen much fat; considerable epigastric tenderness and induration in right upper quadrant, lower quadrants negative, penis and rectum normal, weight 163 pounds. Voided urine was alkaline, specific gravity 1.003, a few white blood cells and bacteria.

Operation was done July 29. Phenobarbital, grains 15, was given in divided doses as preparatory measure. Spinal anesthesia was used. Through a high right rectus incision a long, adherent, scarred appendix was removed. The gall bladder was found to be thick, gray, incomprehensible,

and filled with black bile, much mucus, and sand. Patient's condition on the table became unsatisfactory and it was thought unwise to perform cholecystectomy. Drainage of the gall bladder was therefore carried out with a Pezzar catheter.

Temperature went to 103 degrees on night of operation and to 103.4 degrees the following night, gradually returned to normal but rose to 99.4 degrees almost daily for 3 weeks. The incision healed cleanly. Patient allowed up on twelfth postoperative day. September 17 she was discharged weighing 145 pounds.

The subsequent course has been uneventful. February 11, 1931, she reported her digestion vastly improved, no pain or belching and sensation of fullness rare but drain age was averaging 5 ounces per 24 hours. She was instructed to clamp off the catheter continuously as long as no discomfort resulted. In July 1931 she described her condition as perfect and removal of the gall bladder was advised. January 6, 1932, she reported her digestion excellent, weight 165 pounds. She had been wearing the tube clamped off continuously for 6 months without symptoms. She was still deferring operation because of inability to meet hospital expenses and was to continue wearing the tube until she could arrange to re-enter the hospital for cholecystectomy.

CASE 11. Dr. F. S. aged 64 years, was admitted to hospital September 4, 1930. He had had a posterior gastroenterostomy in 1914 for duodenal ulcer with relief of pain but persistence of occasional attacks of nausea were relieved by induced vomiting of large amounts of bile stained fluid. Ten years ago he began having mild attacks of pain in the right upper quadrant with nausea and vomiting followed by tenderness in the upper abdomen for about a week. Attacks were precipitated by eating sweets, meat, or fried foods. One week ago he had a very severe attack of pain in the right upper quadrant and back and to relieve pain induced vomiting and took morphine. Temperature 102 degrees, he had no chills or jaundice and no abnormal stools.

Examination revealed weight 142 pounds. The head, neck, and chest were essentially normal for his age. There was a rather marked thickening of the peripheral vessels. Blood pressure was 150/86. The right upper quadrant was tender, the liver was palpable one to two finger breadths below the right costal margin, the edge was sharp and tender, there was marked positive infibulation. There was an old healed midline scar. Temperature was 99.6 degrees, pulse 90, respiration 22, white blood cells, 10,000, red blood cells 3,800,000, hemoglobin 85 per cent, van den Bergh, negative, icterus index 4.8, no protein, nitrogen 25. Urine on September 6, acid, specific gravity 1.020, microscopically and chemically negative. A transfusion of 500 cubic centimeters citrated blood was administered and patient was discharged on September 11 because of head cold which had been hanging on for several days. He was readmitted September 18 and he was operated upon the following day.

Theobrominal grains 22 were given as a preliminary measure. Nitrous oxide gas plus novocain infiltration and block anesthesia were used. A large non faceted pigment stone was removed from the gall bladder, the mucosa of which was grossly necrotic; the gall bladder was stuffed with a small iodoform pack in the hope of obliterating it. All ducts were grossly normal and were not explored. Patient vomited considerably and hiccupped for the first 3 days after operation. His highest temperature was 101 degrees, he sweated profusely and had very obviously had all the operating that he could have withstood. The course thereafter was smooth. The gauze was removed from the gall bladder. A Pezzar catheter was

inserted in its place and the patient discharged on October 1 with the incision healed.

The Pezzar came out in about a week after discharge from the hospital and was not replaced. The fistula healed in 10 days. November 1930 his weight was 157 pounds, September 1931 his weight was 153 pounds, July 1932 his weight was 151. Patient has been working continuously as a general practitioner since 6 weeks after discharge from the hospital. About every 3 months he has an attack of mild pain in the right upper quadrant with nausea both of which are relieved by lavaging his own stomach from which he recovers large quantities of bile tinged fluid. He can still precipitate such attacks by eating too much meat, eggs, chocolate or milk or by getting quite tired. These attacks do not incapacitate him. He enjoys complete comfort otherwise and his strength is good. He considers himself 75 per cent normal.

CASE 12. Mr. J. F. aged 70 years, was admitted to the hospital September 17, 1930. He had had intermittent pain in the left upper quadrant and epigastrium for past 6 months without other symptoms. Five days ago he had begun to vomit almost everything he ate and had had a constant gnawing pain in the epigastrium. He had daily passage of normal stool, no jaundice.

Examination revealed a weak, exhausted elderly man in moderate pain. The head, neck, heart and lungs were normal for his age, no obvious dehydration. The abdomen was very tender in the right upper quadrant. There was marked inhibition on respiration. The epigastrium was less tender. The lower quadrants were negative. The genitalia and rectum were normal. The extremities were negative except for a rather marked thickening of the peripheral vessels. Temperature was 97.9 degrees, pulse, 84, respiration 20, blood pressure 120/80, differential (Schilling) count infectious type urine, acid, two plus albumin, numerous hyaline and granular casts, a few white blood cells.

Patient vomited at intervals for the first 4 days but was thereafter perfectly comfortable, temperature remained normal. September 19, no protein, nitrogen was 64.5, phenolsulphonethylalein no trace 1 hour (intramuscular). Test meal showed no free hydrochloric acid, positive for bile, negative for occult blood. Stools were of normal color and negative for blood. Gastro-intestinal and gall bladder series of films revealed a deformed gall bladder shadow with some pulling of the second portion of the duodenum toward the right. September 22, phenolsulphonethylalein 345 cubic centimeters, 24 per cent in 2 hours (intramuscular). Urinalysis showed specific gravity 1.005, microscopically a few organisms. September 30, phenolsulphonethylalein 375 cubic centimeters, 47 per cent in 2 hours (intravenous). Amount of urinary output during this pre-operative course was not recorded.

Operation was done October 3. Nitrous oxide gas, ethylene plus novocain infiltration and block anesthesia were used. The gall bladder was incompressible and adherent to the duodenum by extensive adhesions, the pylorus bound down but normal on palpation and inspection. Cholecystotomy was performed by the usual technique, drainage was carried out with a Pezzar catheter.

The postoperative course was entirely smooth and on October 13, patient was discharged. A report from his referring physician at the present time states that the patient wore the tube 8 months, had no pain, but occasional belching after meals, regained normal strength and weight. At the end of 8 months the tube broke off at the level of the skin and he entered another hospital as a clinic patient where the tube was removed and cholecystectomy was performed because it was felt that the gall bladder was not functioning. His present health is said to be good.

CASE 13. Mr. H. V., aged 53 years, was admitted to the hospital January 24, 1930. He complained that 20 years ago for a period of about 6 months he suffered fullness and dull discomfort in the right upper quadrant after eating meat and fried foods. He eliminated these foods from his diet and enjoyed fair comfort until 8 years ago when pain recurred and he was slightly jaundiced for 2 or 3 months and had clay colored stools. Indigestion persisted until 6 months ago when agonizing pain recurred with nausea and vomiting during which a left inguinal hernia appeared. Intermittent pain and great eructation had been present since this attack. His best weight was 230 pounds, fifteen years ago. His average weight is 125 to 128 present weight, 115 pounds.

Examination revealed a small, thin man looking older than his years. Skin and sclera clear, mouth foul, heart and lungs normal, blood pressure 120/70. The abdominal muscles were very lax and there was an obvious bulge in the right upper quadrant representing the liver which extended from the sixth intercostal space in the right midclavicular line to four finger breadths below the costal margin, edge rounded, quite tender. The gall bladder was not palpable. The lower quadrants were negative. The extremities were negative. The temperature, pulse, and respiration were normal, blood and urine normal, stools, normal, negative for occult blood. Phenolsulphophthalein output was 340 cubic centimeters, 85 per cent in 1 hour (intravenous) electrocardiograms showed ventricular extrasystoles and left axis deviation. Gastro-intestinal X-rays showed the second portion of the duodenum pulled to the median line, the stomach emptying promptly and a redundant colon lying largely in the pelvis. He was given blood transfusion and 70 cubic centimeters 10 per cent calcium chloride intravenously on successive days before operation. Pre-operative diagnosis was chronic cholecystitis and chronic choledochitis, question biliary cirrhosis.

Operation was done in January 1931. Phenobarbital, grains 15 were given in preparation. Ethylene anesthesia was used. Through a right rectus incision the right lobe of the liver presented a rounded border of finely granular surface, grayish-red in color, no gross nodules. On the peritoneal surface of the ascending colon were several firm yellow nodules the size of BB shot, one of which was removed for biopsy. The gall bladder was enormously dilated, not adherent, thin walled, and incompressible. The pyloric end of the stump and transverse colon were attached firmly to the region of the common duct which could not be readily palpated. The spleen was smooth, somewhat enlarged. The gall bladder was aspirated of greenish, normal appearing bile and then a large soft rubber tube was inserted into it and transfused. A small wedge was taken from the liver edge for biopsy. A drainage tube was clamped for gradual decompression. The wound was closed about the tube. Pathological report of the nodule from the colon was vegetable fiber stalk with foreign body reaction and fibrous connective tissue encasing it. The section of liver showed moderate degree of pigmentation and low grade chronic inflammation and infiltration. Diagnosis: low grade chronic hepatitis.

Patient was returned to room with pulse 84. Decompression of the gall bladder was carried out by releasing 1 ounce of bile from the tube every hour for the first 24 hours. Continuous drainage was then allowed. The highest temperature was 101 degrees on first day after operation. It was normal after the fourth day. The patient, however, was extremely weak and we felt assured that more radical operation would probably have proved fatal. For the first 7 weeks, bile drainage varied from 450 to 1,300 cubic centimeters per 24 hours, averaging about

700 cubic centimeters. Bile salts were fed by mouth and the patient's condition gradually improved. On the tenth postoperative day he was given another blood transfusion on the twelfth day he was allowed up, on the fifteenth day the tube came out of the gall bladder and was replaced with a Pizzari catheter and the bile drainage was less than 500 cubic centimeters per 24 hours at all times. February 22 he was discharged with instructions to replace all bile drainage as retention enema when it amounted to more than 200 cubic centimeters per 24 hours.

The Pizzari came out one month later and as the drainage had greatly diminished in amount and stools had been of normal color at all times it was not replaced. The fistula closed in 20 days. July 5, 1932, patient returned weighing 125 pounds, having had perfect digestion ever since operation. No pain or jaundice; no sensation of fullness or belching; liver edge still nearly to umbilicus, but edge is sharp and upper border at sixth rib by percussion and is apparently only ptosed rather than enlarged now. Patient has urinary symptoms with 2.5 ounces residual urine because of a small fibrous prostate which will probably require a caustic punch. Following elimination of this source of straining we will repair his inguinal hernia.

SUMMARIES OF CASES

1. A patient aged 57 years, recently jaundiced, had suppression of urine, nitrogen retention, hypertension, positive urine of low specific gravity, no edema but marked diuresis, on recovery. At second admission, following cholecystectomy the urine was of higher specific gravity, hypertension was improved. Cholecystectomy was done. Patient now has developed diabetes mellitus, toxic adenoma of thyroid, hypertension is still present, gastro-intestinal status is excellent.

2. Patient aged 53 years, jaundiced, had suppression of urine, nitrogen retention, increasing blood pressure, positive urine of low specific gravity, edema. She died without operation. Gross autopsy only was done.

3. Patient aged 71 years, jaundiced, had 42 per cent retention of io-iodexon in 30 minutes (liver failure) on admission, suppression, nitrogen retention after partial diuresis, positive urine of low specific gravity, edema, low blood pressure, slow pulse. Patient died without operation. Autopsy showed characteristic kidney lesions.

4. Patient aged 53 years, jaundiced, was known to have had normal urine and normal phenolsulphophthalein output 1 month before suppression, nitrogen retention, edema. Urinalysis was not reported. Patient died without operation. No autopsy.

5. Patient aged 61 years, jaundiced, showed positive urine of moderate specific gravity on entrance and slight nitrogen retention 3 days later. Jaundice subsided. One week after cholecystectomy and exploration, common duct developed moderate suppression, nitrogen retention, positive urine, simultaneous with blocking internal bile drainage, cause unknown, and deepening jaundice. Death occurred and no autopsy was obtained.

6. Patient aged 63 years, had never been jaundiced. On admission to hospital with empyema of gall bladder she showed suppression, no nitrogen retention, positive urine, slight hypertension. No function tests were recorded. The output rose after operation. Cholecystectomy was done. Convalescence was normal until he died suddenly from pneumonia on eleventh day. No autopsy was made.

7. Patient aged 37 years, recently jaundiced. Urine was normal and of rather low specific gravity (1.014 highest recorded) and decreasing phenolsulphophthalein output (37.5 per cent) on first admission. Cholecystectomy was done. The phenolsulphophthalein output increased to 53 per cent. Cholecystectomy was done after

lipiodol injections showed patent common duct. Present status revealed definite hypertension (155/95) only partly due to toxic thyroid.

8. Patient aged 64 years, had had a subsiding jaundice of recent origin, with urine practically normal, no nitrogen retention, good phenolsulphophthalein output. Graded operation was chosen because of the age and general weakness of patient since exploration of common duct was indicated. Cholecystostomy was done. On second admission, lipiodol injection was done through a Pezzar catheter and showed a block of the common duct and little alteration in the hepatic tree. Cholecystectomy and choledochostomy (T tube) were withstood. Check up lipiodol injection through T tube showed patent common duct before removal of tube. Present status is excellent.

9. Patient aged 63 years, had very slight subsiding jaundice. The findings were very similar to those in Case 8. Graded operation was done because of weakness and age. Patient lost 25 pounds in weight. Exploration of common duct was indicated. Cholecystostomy was done. Patient was discharged and readmitted for choledochostomy which was well withstood. Present status is excellent.

10. Patient aged 49 years, never had been jaundiced. Urine was normal, no functional test recorded. Staged operation was not planned. Condition became poor on tube after only appendectomy. Present status is excellent. She is still wearing Pezzar catheter. Cholecystectomy is still to be done.

11. Patient aged 64 years, had never been jaundiced. The urine was normal, there was no nitrogen retention, but a moderate anemia. Patient had marked arteriosclerosis he seemed "older than his years." Cholecystostomy was planned and performed. He could not have withstood more. Present status is 75 per cent normal.

12. Patient aged 70, had never been jaundiced. He was admitted to hospital in acute attack of cholecystitis, phenolsulphophthalein output was not recorded, there was nitrogen retention. Urine was positive, no phenolsulphophthalein excretion at first test. Function improved as attack subsided. Permanent cholecystostomy was advised because of his age and so severe an illness. We do not approve of his reoperation elsewhere.

13. Patient aged 53 years, was jaundiced in the past. His urine was normal, function good. He was thin and run-down. With gross liver changes present at operation and old extensive adhesions around common duct it was thought unwise to proceed beyond cholecystostomy. This was borne out by his course in the hospital. Present status is excellent.

Cases 14 and 15 are mentioned merely because the lipiodol injection through T tubes in their common ducts illustrate so well the value of this method of outlining the biliary tree. The dilatation of the intrahepatic radicals shows clearly persisting 10 months after plastic operation for stricture in Case 14. The film of Case 15 taken 12 days after choledochostomy shows the same dilatation and prompt emptying of the ducts. If it is desired to outline the biliary radicals in the liver injection through Pezzar catheter in the gall bladder or through the T tube in the common duct should be made with the patient in the Trendelenburg position under the fluoroscope. We had been making such observations for about a year before the publication of

Overholt's preliminary report. The plan is very useful, it is a real addition to our means of following patients with therapeutic biliary fistula. We hope to see the dilatation of the intrahepatic radicals disappear in Case 15 before we remove the T tube for this would be the best evidence of restitution of normal anatomical status. When we have been able to follow with lipiodol injection the course of a larger group now under observation Dr John Young and the author propose to publish the results in full.

Excluding Case 5 which occurred previous to the start of this study 56 patients with diseases of the biliary tract have come under our care. Operation was not performed in 3 (Cases 2, 3, 4). On the remaining 53 patients primary cholecystectomy was performed in 37 cases with exploration of the common duct in 2. There were 2 deaths in this group both of overwhelming pneumonia and septicaemia, one occurring on the sixth, the other on the eighth postoperative day, in women under 40 years both occurred previous to the adoption of carbon dioxide inhalations as routine postoperative care. Cholecystostomy was done as the first step of a contemplated graded operation in 6 patients (Cases 1, 6, 7, 8, 9, 10), followed by subsequent cholecystectomy in 2 (Cases 1, 7) by exploration of the common duct with cholecystectomy in Case 8 and without cholecystectomy in Case 9. Case 10 has not yet had her final operation. The one death in this group occurred in Case 6 pneumonia developing on the fourteenth day after a reasonably smooth postoperative course. Cholecystostomy as the only contemplated operation was performed in 5 patients among whom are Cases 9, 12 and 13. temporary drainage of the gall bladder was instituted in 2 other patients, one being a woman operated on with a diagnosis of perforating ectopic pregnancy and found to have acute appendicitis and a gall bladder full of calculi, the other a man on whom appendectomy was performed in an interval of intermittent appendicitis, the gall bladder being somewhat thickened, without stones but high under the liver and very difficult to reach. Secondary cholecystectomy was performed on 2 patients, one of whom had had a stone left in the cystic duct following cholecystostomy elsewhere 6 months previously, we had performed cholecystostomy on the other patient 9 years previously. In the 3 remaining cases exploration of the common duct for stricture in one case and for stone in the other 2 was performed. The patient with stricture and one of those with stone were jaundiced at the time of operation, they were the only cases of

all the jaundiced patients that bled after operation in spite of the usual preparation with calcium chloride and transfusion of blood.

Until recently there was no clinically useful dye test for liver function. With the introduction of iso-nodexon, such a test seems at hand. We do not look for any great reduction in post-operative mortality from its use in our own practice for it is obvious that we have not been operating upon patients with badly failing livers. We feel that wider appreciation of the need for thorough evaluation particularly from the standpoint of the renal anatomical and physiological status, of all patients with biliary tract disease will be more generally effective in reducing operative mortality. Renal insufficiency occurs in such patients in the absence of jaundice, especially in patients in an acute exacerbation. The occurrence of nephritis in them must be laid to infection, and a study of the infecting organism in such cases is especially indicated. *Acute nephritis is uncommon in other diseases of the abdominal viscera amenable to surgical attack.* It is a fact that operations on only the biliary tract are done for chronic intra-abdominal infections, with the exception of those on the female pelvis in whom conditions for absorption, localization, and drainage are quite different. (We see little clinical or pathological evidence for the existence of chronic appendiceal infection unmarked by exacerbations recognizable as acute attacks.) We believe that for this reason an unbearable burden is thrown on the kidneys more often in operations on the biliary tract than elsewhere. The point can be forced to an extreme by considering how often nephritis and anuria would occur if patients with scarlatina were given an ether anesthesia lasting for an hour and subjected to a major operation!

Simply because the barbituric acid compounds are excreted largely through the kidneys, we do not propose to use them as pre-anesthetic preparation for this group of patients in the future. Where a stage operation has been decided upon, paraldehyde or some other drug excreted through the lungs, can be given by rectum before taking the patient to the operating room. A light nitrous oxide or ethylene anesthesia should be used to mask the infiltration and blocking of the abdominal wall. Cholecystostomy can then be performed by the technique outlined in the case histories in less than 15 minutes, ordinarily. If an inhalation anesthetic is required ethylene is preferable to nitrous oxide since any degree of cyanosis threatens all cellular metabolism. Morphine should be used very sparingly for the same reason.

CONCLUSIONS

1. A review of the literature on renal complications of biliary tract disease is given.

2. Six cases of nephritis with suppression of urine complicating biliary tract infections are presented. To these a seventh (Case 12) should probably be added. With one exception (Case 5) these occurred in a series of 56 consecutive patients, an incidence of 10.7 per cent.

3. This complication occurs at times, particularly in acute exacerbations, without jaundice and can be detected in its incipency. Functional tests are discussed.

4. Excretion of phenolsulphonophthalein in patients in whom primary cholecystectomy or choledochostomy was performed has varied only within the normal range for the age of the individual.

5. There is no evidence that hepatic cell damage serious enough to cause liver failure must precede renal damage though ordinarily the two are associated.

6. Stage operations are advocated for patients who have suffered from renal complication, as well as for all seriously depleted patients with biliary tract disease. Illustrative cases are presented in which cholecystostomy is done as a preliminary step and others in which it is the only operation contemplated.

NOTE.—Since this paper was submitted for publication, an article by Helwig and Schuts has appeared, which deserves comment. They regard nephritis as secondary to degeneration of liver tissue, as did some of the early German authors. They correctly note the locustancy of jaundice as an etiological factor. However, their observations and conclusions may be adversely criticized on the following points: (1) They disregard the evidence of active infection in Cases 1, 3, 5 and 6 (exacerbation of symptoms before operation and acute inflammation found at operation) as unimportant in precipitating post-operative renal failure. (2) They describe laboratory findings as being "normal" before operation, which raises the suspicion that a blood non-protein nitrogen determination within normal limits was accepted as evidence of normal kidneys. (3) Their experimental work consisted in producing a limited necrosis of the liver by trauma. The production of acute nephritis by liberation of products of aseptic necrosis of other tissues (as in skin burns and in acute pancreatitis with \pm necrosis) is well known, their experiments are not evidence for specific action of liver necrosis on the kidney parenchyma. (4) They characterize the condition under discussion as "hepato-renal syndrome" which obscures the clear-cut evidence that acute nephritis following infection in the bile passages or destruction of liver tissue (just as after infection in the throat) occurs more frequently than has been previously thought. The statement that the "syndrome" has been previously undetected is hardly warranted, in view of the literature which they as well as I, have summarized.

I am satisfied that we are both describing the same clinical condition, they disregard the role of infection in the bile passages as being the direct cause of the nephritis.

while I consider it of the greatest etiological importance and believe that a specificity for renal tissue of the toxins of the infecting organisms will eventually be shown.

A recent communication by Cinsburg calls to my attention a previous publication of lipiodol injections through biliary fistulae with very satisfactory results.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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JUNE, 1933

THE CENTURY OF PROGRESS

FUR Trading Indians French Wars, Missionaries Cholera, Fort Dearborn The United States Army Emigration from the East Fort Dearborn Massacre, Rail Splitting Primitive Medicine and Midwifery War Wounds Vision Courage Faith Perseverance Foundation of Medical Schools and Societies, Success Such are the chapter headings of the history of Chicago and its environs of a century or so ago.

During the intervening years Chicago has run the gamut of the helps and hindrances of civilization. Its strategic geographic situation and the character of its citizenry have drawn to it everything that goes to make up a metropolitan center of cosmopolitan interests and to establish it as an epitome of world progress.

Forty years ago in Chicago the discovery of America was memorialized by the Columbian Exposition the world's fair after which subsequent world's fairs have been patterned. This year the centennial of Chicago will be memorialized by a Century of Progress a new type of world's fair in which the nations will

co-operate to display the present scientific, religious, and artistic status of the world.

From June 1 to November 1 the beautiful lake front of Chicago will present the forefront of the march of progress in achievement. The very inventions and discoveries of the Century which have brought about the present mechanical age have made it possible to make the displays in a way that was heretofore impossible.

The science and art of the engineering profession have produced changed conditions of life, and the science and art of the medical profession have made life safer better and longer under these new conditions.

The products of the basic sciences of chemistry and physics as exemplified in the conversion of raw materials into articles of utilitarian and artistic value will be exemplified and the leading spirits of the exposition have set a new tempo by emphasis on a display of the processes of manufacture as well as on the finished products.

The use of steam, oil gasoline, and electricity in the production of light, heat and power and the application of these to mining agriculture and manufacture, transportation communication and illumination are products of this last century and so will occupy important places in the exposition.

The artistic side will be interwoven in all phases of the Fair by a new use of color light architecture sculpture and painting.

Of particular interest to the medical profession will be the exhibits on the medical and biological sciences which will receive a prominence not hitherto accorded them in such general expositions. Universities, national

state, and civic medical institutions and commercial organizations will vie with one another and the result cannot but be reflected in a better comprehension of medical and surgical problems by the public. From this will come improved health of the people through a better and surer knowledge of how disease is caused, prevented and cared for, and how these benefits may be derived from the medical profession.

The American Medical Association, the American Dental Association, the Wellcome Research Institution, the American College of Surgeons, a number of our universities and large private medical clinics have prepared attractive and instructive exhibits. The following is a brief summary of the exhibit of the American College of Surgeons.

Improvements in surgery in America during the past century will be portrayed by five beautifully executed dioramas. Details of hospitals and their care of the sick and injured during the nineteenth century and today will be depicted by transparencies, models, a semi-diorama, and an illustrated map. A replica of the Lister exhibit in the Wellcome Historical Medical Museum. SURGERY, GYNECOLOGY AND OBSTETRICS, the official journal of the College, will exhibit an authentic record of surgical progress. The College activities, surgical progress and service to the public will be described through illustrated lectures. The objects and activities of the College will be further illustrated by illuminated wall plaques. The exhibit will be enhanced by the use of portraits of eminent American surgeons of the century, the Great Mace of the College, the Seal of the College in magnified form, and by other means.

During the period of the Century of Progress, Chicago will be host at the annual meetings to a number of the national medical organizations.

ALLEN B. KANAVEL.

SUBPHRENIC INFECTIONS

UNFORTUNATELY the importance of subphrenic infections is not sufficiently appreciated by most surgeons. The majority of subphrenic infections are the result of an intra abdominal contamination usually caused by extension of micro-organisms from an abdominal viscus. Rarely subphrenic infections may extend from extra abdominal foci either by direct extension (from the thorax) or through the blood stream. Only a relatively small percentage of subphrenic infections proceed to abscess formation. By far the larger number resolve spontaneously, which probably accounts for the fact that subphrenic infections without abscess are relatively infrequently diagnosed. The most frequent cause of subphrenic infection is post appendiceal peritonitis. However in all cases of acute peritonitis the possibility of the development of a subphrenic infection must be kept in mind, as in this way the early diagnosis is facilitated. Subphrenic infections following acute appendicitis characteristically are found most frequently in the right posterior superior space, viz. above the liver on the right side and behind the right prolongation of the coronary ligament. This infection is manifest clinically by a persistent point of tenderness over the right twelfth rib. An infection inferior to the liver but on the right side, i.e. right inferior space infection, may occur concomitantly with right posterior superior infections.

The prognosis in subphrenic infections is very good because only relatively few of the infections progress to suppuration. The prognosis in subphrenic abscess has been considered as being especially grave, due to two facts: (1) the diagnosis of the infection is made relatively late and (2) most subphrenic abscesses have been drained either transpleurally

or transperitoneally and because of contamination and subsequent infection of one of the large serous cavities (the pleural or peritoneal) an overwhelming and fatal toxemia develops. The mortality rate in collected series of cases varies from 20 to 100 per cent. In the treatment of subphrenic abscess the same surgical principles as used elsewhere in the body should be applied. Whereas it is frequently possible to drain an intraperitoneal abscess through an uninvolved peritoneum by attempting to protect the virgin peritoneum from contamination it is far better to drain the abscess extraperitoneally as the danger of contamination of the peritoneum is thus obviated. Similarly it is far better to drain subphrenic abscesses extraperitoneally in such a way that contamination of the pleural and peritoneal cavities is prevented. In abscesses pointing anteriorly extraperitoneal approach is possible by reflecting the peritoneum from the under surface of the diaphragm until the abscess is encountered. In those abscesses pointing posteriorly the retroperitoneal operation (2) permits adequate exposure and drainage of abscesses in this region without the danger of contaminating either the peritoneal or pleural cavity. The advantage of the extraperitoneal operations over the other methods

of approach is exemplified by Flynn's (1) statistics of cases of subphrenic abscess operated upon by members of the Southern Surgical Association. In those cases in which operation was by the transpleural transperitoneal or extraperitoneal method the mortality rate was 37.9 per cent. In those cases in which operation was by transpleural or transperitoneal routes the mortality rate was 41 per cent. whereas in those cases in which operation was by the extraperitoneal technique the mortality rate was 18.4 per cent. In 10 personal cases operation was by the retroperitoneal operation and there was but one death a mortality rate of 5.2 per cent (3). In fact it is my firm belief that subphrenic abscesses should be treated successfully with no mortality. This can be accomplished however only by the early recognition of the condition and the institution of adequate drainage without contaminating uninvolved serous cavities. ALTON OCHSNER

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JOHN SYNG DORSEY

1783-1818

MASTER SURGEONS OF AMERICA

JOHN SYNG DORSEY

FROM time to time in history there have lived men who have been able to accomplish a full life's work within a brief span of years. A man of this mold John Syng Dorsey was able during his thirty five years of life to reach a prominent place in American surgery of the early nineteenth century. Like his contemporary the great composer Franz Schubert who lived but thirty one years he seemed unconsciously to sense the need for filling every moment so that his successive achievements came with dramatic frequency.

Members of the old English family of Dorsey were early settlers in Maryland, but John was born in Philadelphia in 1783 where his father Leonard Dorsey was a prominent merchant. Young Dorsey passed rapidly through his classical studies at the Friends Academy and the University of Pennsylvania overcoming the handicap of a slight defect in speech and graduating with distinction at the age of fifteen years. He began at once the study of medicine at the University of Pennsylvania under the guidance of his noted uncle Dr. Philip Syng Physick, who held the chair of surgery at that time. A year prior to his graduation he was honored with a membership in the Medical Society of Philadelphia, Benjamin Rush was then president of the organization. In that same year Dorsey became a member of the Chemical Society of Philadelphia an organization "desirous of promoting the cultivation of the science of chemistry in the United States of America by associating with themselves persons of distinguished talents." In 1802 at nineteen years of age he defended his thesis on "The Powers of the Gastric Juice as a Solvent for Urinary Calculi" and received his degree of Doctor of Medicine a special dispensation from the board of trustees waived the requirement that candidates for the degree must be twenty-one years of age.

Coincident with his graduation occurred one of the severest epidemics of yellow fever in the history of Philadelphia, and young Dr. Dorsey was made resident physician of one of the emergency hospitals. During his year of service there he demonstrated his sincere faith in his own reasoning and convictions. He believed with Devereze that yellow fever was not contagious and fearlessly went about the care of his patients constantly exposing himself to the disease whereas many of his confrères who entertained similar ideas were unwilling to vindicate them.

In 1803 Dorsey sailed to Europe for a year of study. The entire winter was spent in London where he attended the lectures of the famous chemist Sir Humphry Davy but spent the most of his time in John Hunter's anatomical school where in former years his uncle Dr. Physick had so distinguished and endeared himself that the great anatomist had made an offer of partnership. Dorsey spent the remaining portion of the year in Paris where he continued his studies in anatomy.

In 1804 Dorsey returned to Philadelphia and prepared to practice his profession. Those first few years must have carried all of the traditional monetary anxiety for his old account books reveal that his income for the first year was only \$3 5 75. However appreciation of his ability spread steadily and in a few years he was considered one of the most skillful surgeons in the country. He was elected to the staff of the Pennsylvania Hospital where the first ligation of the external iliac artery for aneurism was performed by him. It was during this period that he prepared the manuscripts for his great book *Elements of Surgery* a work which received much recognition and was reprinted in Edinburgh as a textbook for the university. The material it contained was drawn partly from his own experience but largely from the experience of his uncle Dr. Physick, to whom the book was really a monument for Dr. Physick left but few writings of his own. Dorsey's talent and training as a draftsman enabled him to prepare his own beautiful illustrations.

At the age of thirty two Dorsey accepted the chair of materia medica in the University of Pennsylvania and soon endeared himself to his pupils by his tireless interest in their work and the frank sympathetic manner of his teaching. Following the example of Wistar he valued and thoroughly enjoyed informal gatherings with his students where exciting controversies often developed stimulated by his clear direct thinking and youthful enthusiasm. He loved to debate and his discussions at medical meetings always attracted interest often were at variance with current opinion but never were injured by petty meanness or personal rancor. His association with great men abroad and his great love for music and poetry mellowed the brilliance of his scientific fervor and made his character of outstanding appeal.

In 1818 occurred the sudden death of Dr. Caspar Wistar the highly respected and much loved professor of anatomy at the University of Pennsylvania. It was he who had first developed in this country the continental plan of informal discussions between professor and students and it was through his efforts over a long period of years that the teaching of anatomy had reached such a high plane there. John Dorsey was selected to fill the vacant chair a difficult task but one which he accepted with sincere confidence and reverent respect for his predecessor. On November 12 1818 he delivered the introductory lecture to his students. It was an inspiring talk of outstanding richness of thought, carefully designed to lead the

beginners in medicine beyond the unfamiliar horrors of the dissecting room to an earlier realization of the value of true knowledge and a visualization of the long vista of interesting work before them. No oratorical displays of rhetoric or eloquence can aid the anatomist to enliven your attention. he told them "his eloquence is of the hand, his rhetoric of the scalpel! But when the years shall have rolled away and your memory shall be tasked to recall the vestiges of scholastic learning when your teacher's tongue shall be silent and his hand motionless, then the impressions derived through the medium of your senses will be found fresh and vivid long after the collections of impassioned oratory shall have faded from your minds.

The tragic drama of this counsel was to be realized with terrible suddenness. Within a few hours after this Dorsey's first address to his class he was stricken with a fatal illness which proved to be typhus fever. He died ten days later thus ending at thirty five years a career of such achievement as to rank him among the foremost surgeons of his time and of such promise that inevitably he would have been grouped with the great men of all time. LEONARD FREEMAN JR

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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PLANS FOR THE 1933 CLINICAL CONGRESS IN CHICAGO

FOR the twenty third annual Clinical Congress of the American College of Surgeons, to be held in Chicago October 9-13, 1933, the surgeons of that great medical center are keenly interested and have organized to provide for the Fellows of the College and their guests, a program of surgical clinics and demonstrations that will present a most complete showing of the city's clinical activities in all departments of surgery. In these plans the Committee on Arrangements has been assured of the hearty co-operation of the surgeons of the four medical schools and more than fifty hospitals that will participate in the clinical program.

It will be recalled that the first Clinical Congress was held in this city in 1910 and that out of that meeting largely attended by enthusiastic surgeons from all parts of the United States and Canada, came the organization of the College which this year celebrates its twentieth anniversary.

The Congress will open at 10 o'clock on Monday, October 9, with the annual hospital conference to be held in the ballroom of the Stevens Hotel. An interesting program of papers, round table conferences and practical demonstrations dealing with problems related to hospital efficiency is being prepared for presentation at this conference which will continue on Tuesday and Wednesday. The program is being prepared with a special view to interesting surgeons, hospital trustees, executives, and personnel generally.

Among the outstanding features of this year's session of the Clinical Congress will be (1) a symposium on cancer under the auspices of the College Committee on the Treatment of Malignant Diseases on Thursday afternoon following the annual meeting (2) a conference on fractures arranged by the College Committee on the Treatment of Fractures, on Wednesday afternoon.

A preliminary program of clinics and demonstrations is being prepared under the supervision of the Committee on Arrangements for publication in an early issue of this journal. Operative clinics and demonstrations in the hospitals will be scheduled for Monday afternoon, October 9, beginning at 2 o'clock and for the mornings and afternoons of each of the four following days. All departments of surgery will be represented in this clinical program—general surgery, obstetrics, gynecology, urology, orthopedics, and surgery of the eye, ear, nose and throat. Hospitals participating in the program are:

Alexian Brothers	John B. Murphy
American	Oak Park
Angstrom	Pasadena Memorial
Albert Merritt Billings	Post-Graduate
Chicago Eye, Ear, Nose and Throat	Presbyterian
Chicago Lying In	Ravenwood
Chicago Memorial	Michael Reese
Children's Memorial	Research and Educational
Columbus	St. Anne's
Cook County	St. Anthony de Padua
Evangelical Deaconess	St. Bernard's
Evangelical	St. Francis
Evanston	St. Joseph's
Garfield Park	St. Luke's
Grant	St. Mary of Nazareth
Hennolt	Shriner's
Holy Cross	South Chicago Community
Illinois Central	South Shore
Illinois Eye and Ear	Swedish Covenant
Illinois Masonic	U. S. Marine
Jackson Park	U. S. Veterans
Lake View	University
Little Company of Mary	Washington Boulevard
Lutheran Deaconess	Wesley Memorial
Mercy	West Suburban
Mount Sinai	Frances Willard
Municipal Tuberculosis	Women's and Children's

An Executive Committee appointed by the Board of Regents to supervise the development of the clinical program is as follows: Philip H. Kreuscher, chairman; Oscar E. Nadeau, sec-

tary—Joseph Beck William R. Cubbins Frederick H. Falls Harry S. Gradle Carl A. Hedblom Charles E. Kahlke Herman L. Kretschmer Karl A. Meyer Dallas B. Phemister Edwin W. Ryerson and Henry Schmitz. To this group will be added representatives for each of the hospitals co-operating in the clinical program to comprise the local Committee on Arrangements.

Two sub-committees have been appointed to supervise the program for the sections on surgery of the eye, ear, nose and throat as follows: Ophthalmology—Harry S. Gradle chairman Thomas D. Allen, E. K. Findlay Sanford Gifford Otolaryngology—Joseph Beck chairman Austin A. Hayden, Edward P. Norcross S. J. Pearlman. The recommendations of this committee insure a worth while program of clinics and scientific sessions for all those who are interested in these specialties.

Special features of the clinical program will be (1) Demonstrations at several hospitals of modern methods in the treatment of fractures which form so large a part of the surgical work in large cities and industrial centers (2) a series of cancer clinics demonstrating the treatment of cancer by surgery, radium and X ray (3) clinics in traumatic surgery demonstrating methods of rehabilitation by surgery and physiotherapy of patients injured in industrial automobile and other accidents.

EVENING MEETINGS

The Central Executive Committee of the Congress is preparing programs for the series of five evening meetings to be held in the grand ballroom of the Stevens Hotel.

At the presidential meeting on Monday evening following the address of welcome by the chairman of the Committee on Arrangements Dr. Philip H. Kreuscher, the Director General Dr. Franklin H. Martin will introduce the visiting surgeons from foreign countries, a large number of whom have been specially invited to attend the Congress this year. Following the address of the retiring president Dr. J. Bentley Squier, of New York, the president-elect Dr. William D. Haggard of Nashville Tennessee is to be inaugurated. The John B. Murphy oration in surgery will be delivered at this meeting by Dr. Loyal Davis, of Chicago.

At the annual convocation of the College to be held on Friday evening when the 1933 class will be received into Fellowship in the College the presidential address will be delivered by Dr. William D. Haggard and the Fellowship address by Robert Maynard Hutchins, A.M.

I.L.D. president of the University of Chicago. For the sessions on Tuesday Wednesday and Thursday evenings distinguished surgeons of the United States and Canada with visiting surgeons from abroad have been invited to present papers dealing with surgical subjects of timely interest. Among the speakers who will present papers are the following: George W. Crile M.D. Cleveland on Clinical Problems and End Results in the Surgical Treatment of Goiter Edward D. Churchill M.D. Boston Tumors of the Parathyroid Glands Edward C. Naffziger M.D. San Francisco Treatment of Exophthalmos George E. Brown M.D. Rochester Minnesota Thrombo-Angitis Obliterans David Edwin Robertson M.D. Toronto Sympathectomy in Children.

Arrangements are being made for additional sessions on Tuesday and Thursday evenings at which programs of special interest to ophthalmologists and otolaryngologists will be presented.

HEADQUARTERS—HOTELS

General headquarters for the Clinical Congress will be established at the Stevens Hotel located on Michigan Avenue between Seventh and Eighth Streets. This hotel affords unusual facilities for all activities of the Congress, as will be remembered by those who attended the Congress in Chicago in 1929. The grand ballroom on the second floor with other large rooms on the third floor and the exhibition hall have been reserved for the exclusive use of the Congress. All of the evening sessions the hospital conference on Monday the annual meeting the cancer and fracture symposia will be held in the grand ballroom. The registration and information bureau, together with the bulletin boards on which will be displayed the daily clinical program will be established in the exhibition hall in the basement, together with the Technical Exhibition.

Chicago has many fine, large hotels, several within walking distance of the headquarters hotel. A list of the hotels recommended by the Committee on Arrangements will be published at an early date. While Chicago's hotel facilities are very great and there should be no difficulty in securing first class hotel accommodations, it is advisable for those who expect to attend the Clinical Congress to reserve their hotel accommodations as far in advance as possible as the Century of Progress Exposition will undoubtedly bring to Chicago a very large number of visitors.

The Technical Exhibition of the Clinical Congress will be located in the Exhibition Hall together with the registration and information bureau.

eau. In the same room will be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, X ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals and publishers of medical books will be represented in this exhibition.

We are assured that the railways of the United States and Canada will grant especially low rates on account of the Clinical Congress in connection with the Century of Progress Exposition in Chicago. Applications for reduced fares for this meeting are pending before the various railway traffic associations.

ADVANCE REGISTRATION

The hospitals of Chicago afford accommodations for a large number of visiting surgeons, but to insure against overcrowding the attendance will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the results of a survey of the amphitheatres, operating rooms, and

laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore that those surgeons who wish to attend the Clinical Congress in Chicago will register in advance.

Attendance at all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

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